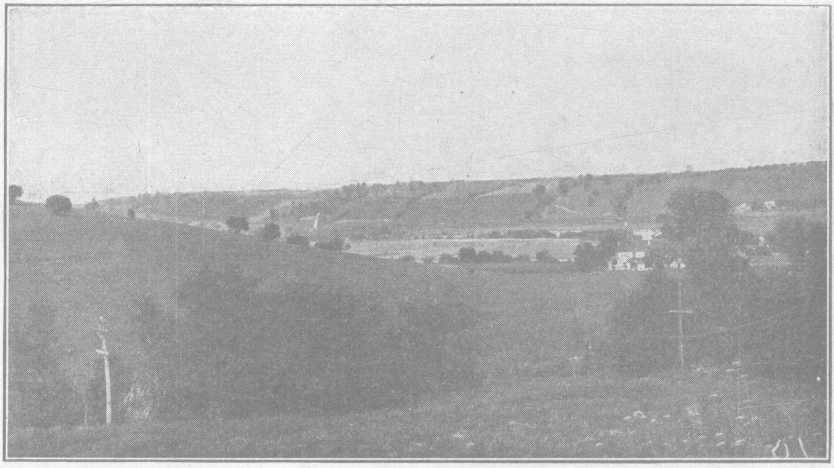
Ohio Agricultural Experiment Station

CIRCULAR No. 113

WOOSTER, OHIO, JUNE 30, 1911

ALFALFA IN OHIO—A FIELD STUDY



SIR:—I have the honor to transmit herewith and to recommend for publication as a Circular by the Experiment Station the accompanying manuscript entitled "Alfalfa in Ohio."

This paper, which has been prepared by Mr. W. M. Cook of this Department, is a progress report of a somewhat extensive field study of the alfalfa crop of Ohio. Of late years much discussion has been indulged in regarding the possibility of growing alfalfa in the various sections of this state and the best method to be used in doing so. After studying the alfalfa crop on almost 300 well distributed farms, it seems to be evident that this difference of opinion is due quite largely to the different conditions different persons have in mind. Methods which are best for one section are not necessarily suited to another. On some soils alfalfa is sown successfully in the wheat or oats just as the red clovers are seeded, while on others very much more care and expense are necessary to avoid failure. It is well for each prospective grower to study carefully his own soil conditions before seeding largely to this crop.

This report is offered as a contribution to the Agricultural Survey of the State which is being undertaken by this Department.

Respectfully submitted,

L. H. GODDARD,

Chief, Department of Cooperation.

Approved:

CHAS. E. THORNE, *Director.*

ALFALFA IN OHIO—A FIELD STUDY

By W. M. COOK

INTRODUCTION

Few if any of the numerous publications regarding alfalfa treat the subject exclusively from the viewpoint of personal field investigations of the work done by the farmers themselves. Such a study in the fields of Ohio growers has been conducted within the past year by the Ohio Experiment Station. In this investigation 293 farmers, well distributed over the state, have been visited (See Fig. 1). The observations of the year's work would indicate the need of a report of progress in which the successful methods of farmers in various sections of the state, with numerous differences, may be called to the attention of those interested.

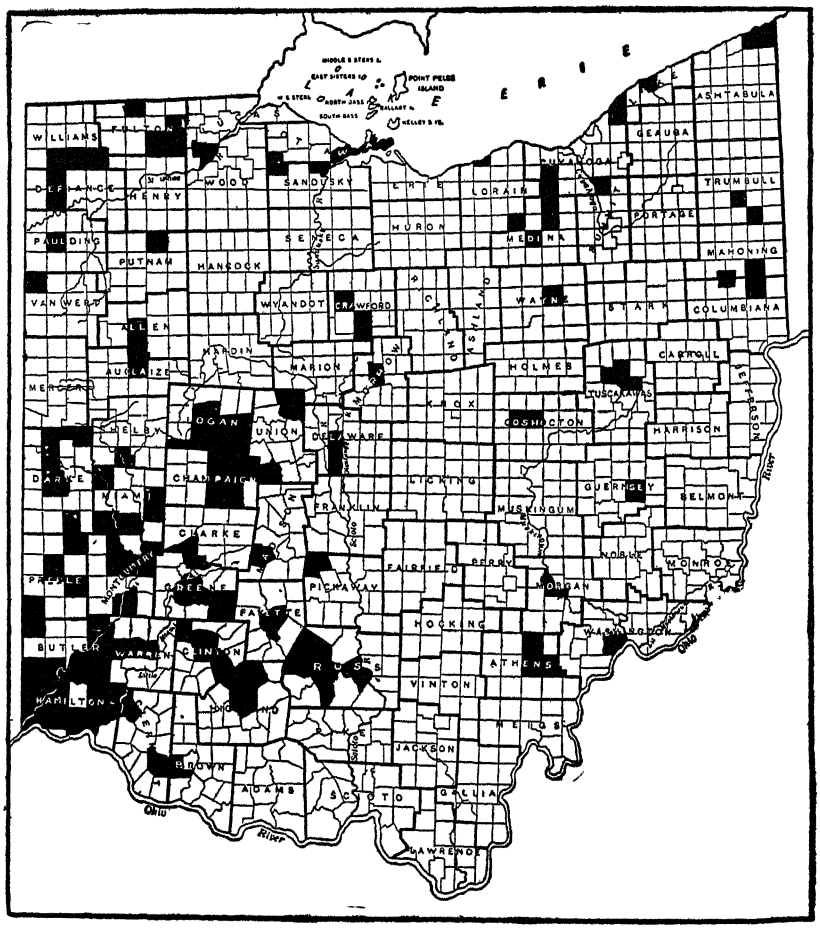


Fig. 1. Map showing townships visited in the alfalfa field investigation during 1910, when 293 farm visits were made in 49 counties of the state.

Acreage. The latest statistical report of alfalfa in Ohio shows the area of 1909 to be 21,794 acres, which is distributed among all the counties of the state excepting two. The official yield of the same year is 49,796 tons or a fraction over two tons per acre. Hamilton county leads in the number of acres grown, with Logan and Montgomery counties, in the order named, only a little behind. The high price of seed during the past few years may in part account for the slow increase of acreage in a number of other counties in which more recent centers of alfalfa production have been formed and which are evidently as well adapted to the crop as the counties containing the older centers where it has been extensively grown for a number of years (see Figure 2).

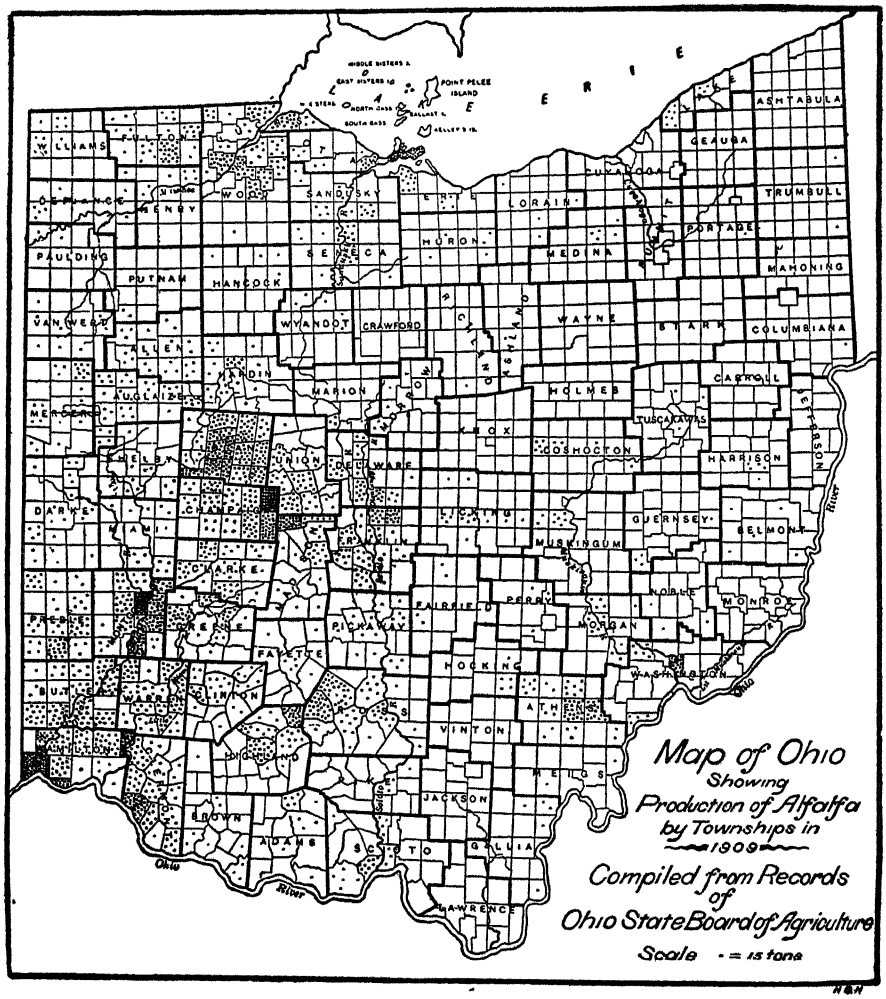


Figure 2. From Circular 100, Ohio Agricultural Experiment Station.

Alfalfa not a new crop in Ohio. It has been the prevailing opinion of late years that alfalfa is a recent introduction into Ohio, and in fact, quite recently, vigorous discussions have been conducted relative to its ever becoming a practical crop far north of Columbus. All this time certain farmers were quietly working out the soil's answer to this question. The oldest field of alfalfa located during this investigation is situated in Lake county, in latitude north of Cleveland. It has stood nineteen years without other attention than at harvest time. The ease of seeding alfalfa in northern Ohio counties where soil conditions are favorable is evident on certain farms in both Fulton and Sandusky counties, where it is seeded in the spring with wheat or oats with as much assurance of a stand as there is with red clover. One field in particular, near Delta in Fulton county, is worthy of mention. The sheaves of oats were green with alfalfa tops which were cut with the binder in harvesting the oat crop. The field was visited again later in the season when a good crop of alfalfa was ready for harvest. A Hamilton county farmer reports an alfalfa field which he often passed 46 years ago, situated along Little Duck Creek, in what is now a part of Madisonville. In Ross county near Greenfield there is a very small patch of alfalfa in a cemetery that was seeded in 1865 with seed brought from Germany. It is therefore quite evident that alfalfa is not a new crop in various parts of the State.

Peculiar requirements of alfalfa. A season's travel throughout the various agricultural sections of the State of Ohio cannot fail to impress one with the characteristic differences of soil problems in their relation to crops produced and methods involved. This fact is probably more particularly true in studying alfalfa, which is more exacting in many of its requirements than are other farm crops grown generally over the State. Differences of latitude, on the other hand, apparently have little to do with the location of the alfalfa centers. The variations of alfalfa yield in different fields apparently have a wider range than the general farm crops, due largely to soil conditions. This more delicate requirement of alfalfa is commonly believed to be due to the greater amount of certain kinds of plant food contained in a given amount of its hay as compared with that of a number of other grasses. However, this does not appear to explain fully the peculiar requirements of alfalfa. Sweet clover (*melilotus alba*) for instance, has about the same analysis as alfalfa, yet is found growing as a weed in parts of the State where alfalfa is grown with difficulty. This same difference between quite similar varieties of plants is further illustrated in the more general adaptability of Canada Blue Grass to soils upon which Kentucky Blue Grass cannot be successfully grown.

LIME, DRAINAGE AND OTHER FACTORS

Importance of lime. The location of the alfalfa fields of the State is to a certain extent a reliable guide to a number of soil characteristics, regarding which this crop is more sensitive than the general crops of the farm. The more important of these are lime and drainage. In addition thereto many local peculiarities exist which are more or less perplexing, although reasonably expected in a new crop upon which observations have not been extensive. The maps in this Circular showing the location of the limestone areas of the State (Fig. 3), as well as the limits of the glacial drift and old Maumee lake bed (Fig. 4), when studied in connection with the crops of the State give evidence of the necessity of considering the lime supply in growing the regular farm crops, and especially so in growing alfalfa, which contains 42 pounds of lime in a single ton of hay, or more than six times as much as is found in one ton of timothy.*

Original lime supply. The underlying limestone is of agricultural value in the various sections of the State where it comes near the surface. This is particularly true of the hills of southwestern Ohio. Along the lake shore and in Ottawa county, especially, this underlying limestone is of practical value for alfalfa growing. However, the limestone of the lake region does not offer the ideal condition for alfalfa unless overlaid with more soil than is necessary for the same crop on the limestone of southern Ohio. One reason for this difference is the character and position of the strata, which in the lake region are large and solid with compact seams, while in southern Ohio among the hills they are more broken and less compactly arranged, thus giving more opportunity for the plant roots to penetrate to sufficient depth.

Coal measure limestone. It is not uncommon in the coal measure areas of the State, as shown in Figure 3, to find an abundance of limestone outcrop on a certain level when both below and above that level there is a deficiency. This is well illustrated in the hills of eastern Ohio, back from the river, where the limestone is found with certain strata of coal outcropping on the highest hills with an evident shortage of lime in the fields lower than this level. Valley soils which have been formed by stream action are frequently well supplied with lime which has evidently been washed from higher hills, that by the process of ages of washing have been largely leveled below the original outcropping limestone formation. In many of the counties classed in the State Geological Report as having limestone both in and out of the coal measures, this formation is located at such a depth that plant roots are unable to reach it.

*Ohio Experiment Station analyses.

There are also small areas where the limestone originally came to the surface and has been disintegrated by continuous weathering to a pure limestone soil. Such a soil is not only valuable for alfalfa, but is probably among the best of the State for general farming.

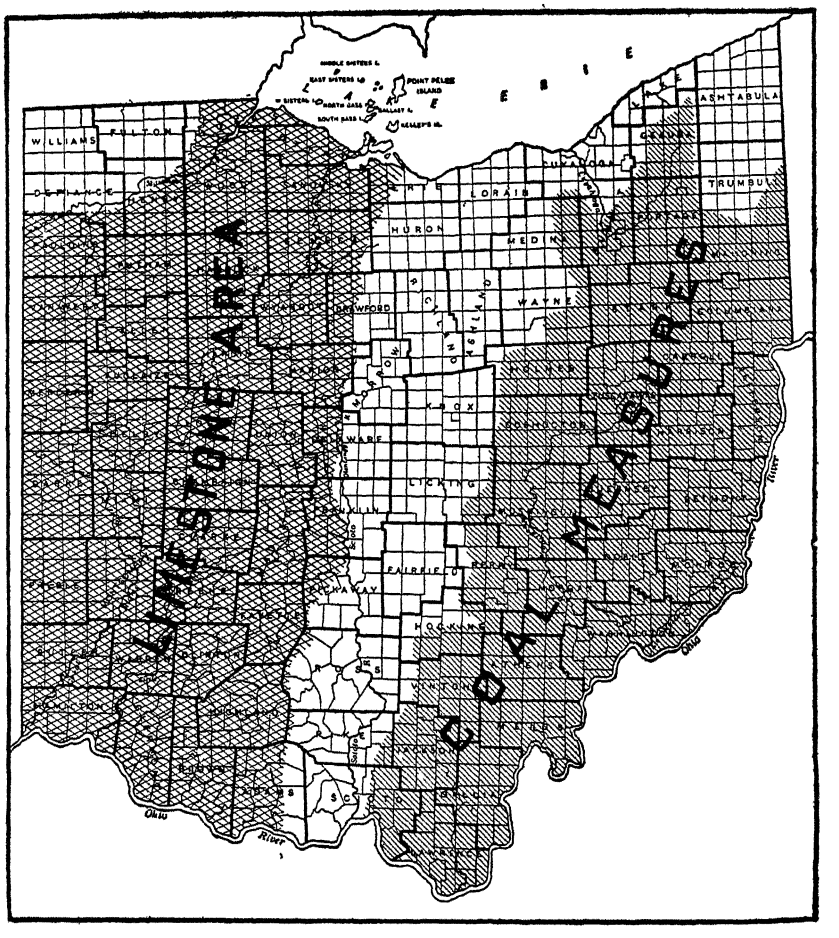


Fig. 3. Map of Ohio showing limestone area, and coal measure area in which limestone frequently appears.

Glacial lime supply. The limestone soils due to glacial action do not occur to a large degree in the eastern part of the State, whereas in the western part numerous areas were thus prepared for ideal alfalfa fields (see Fig. 4). The glacial drift is an important factor in soil conditions of the part of the State over which the glacier passed. The large body of glacial ice which carried northern soils into Ohio and mixed them with the material which it

ground up within that state, deposited a soil rich in limestone throughout much of the area over which it moved, although in the north-eastern part of the State this deposit is of a very different character and seldom contains an abundance of lime. However, limestone material was frequently carried into the freestone areas of the State. In Crawford county acres of limestone gravel have been deposited evidently by glacial action, within a few rods of and possibly joining in places, a sandstone quarry. It is quite evident that under such conditions limestone may be both plentiful and lacking in parts of the same field.

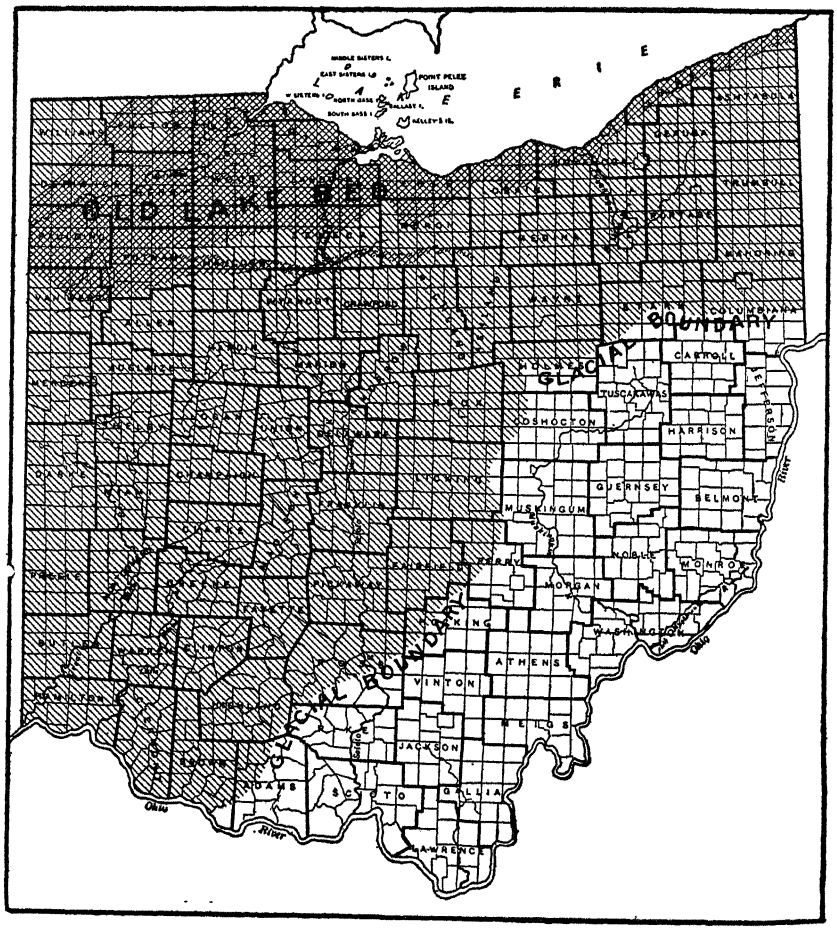


Fig. 4. Map of Ohio showing glaciated area and old Maumee Lake bed.

Old lake bed. Large deposits of valuable lime have been made by the action of the old Maumee Lake which formerly covered an extensive area in north-western Ohio. The bed of this old lake extends as far south as the center of Van Wert county, where its shore is yet visibly marked by a gravel ridge extending across the country in a more or less irregular line in the general direction of Cleveland. A large portion of the State north of this line is included in this area, many parts of which are remarkably rich in lime from the animal life that existed in the lake. The northern boundary line is plainly evident by the difference of soil where it passes through Bryan, the county seat of Williams county. The farmers locally speak of the different character of the soil on opposite sides of this line; the soil generally being considered more productive on the south side. A long and very narrow neck of this lake bed extends east from Hancock county nearly to the south-west corner of Medina county. The location of the southern limit of the lake bed through the eastern part of the State is only a few miles south of the present lake shore. Here it is known locally as "South Ridge". Indian trails formerly followed this gravel ridge in various places and at present wagon roads are constructed along it in a number of counties. During the period of this enlargment of Lake Erie there was an outlet which drained it in a south-westerly direction, extending across the State of Indiana near the present site of Ft. Wayne. The lime deposits which are unquestionably due to the lake that once covered this extensive area are not generally observed, although during the time spent traveling through this section a number of interesting examples were located. Enough were seen to make it quite evident that numbers of areas exist in this part of the State which are well adapted for alfalfa.

Marl. In addition to the more extensive supplies of lime referred to, local deposits of marl rich in lime are found in a number of counties. However, owing to the depth below the surface and the small area of such deposits, their direct supply of lime to the alfalfa fields is not extensive. In a few instances, where such deposits are near streams, the evidence of lime is apparent farther down, indicating that by stream action it has been carried there. Such an effect could be detected only where lime was otherwise deficient. Such deposits were found in Morrow, Lake and Huron counties.

Underlying limestone frequent in western Ohio. The effect of an underlying limestone formation is in evidence over a large part of western Ohio. It is especially marked in Hamilton county,

where alfalfa is grown with little trouble on the stony hillsides. Many of these hills which are so stony that cultivation is next to impossible, grow alfalfa luxuriantly. Several other limited areas in the State have soils of a similar formation to which alfalfa is equally well adapted.

Glacial limestone supply in freestone areas carried by stream action. On the Experiment Station test farm in Cuyahoga county the clay is very tenacious and very deficient in lime, which is also true of the county in general. Near this farm, at Berea, are extensive sandstone quarries covering hundreds of acres, yet less than a mile from Berea up the valley of Rocky River, which flows through the village, is a fine field of alfalfa, indicating an abundance of lime. The natural stone of the stream was examined and no trace of limestone could be found. Neither could the abundant supply of lime be accounted for in any other way at the time the field was visited. Some time afterward, however, while visiting a farmer more than 50 miles away this circumstance was related to him and the whole matter explained by his statement that his grandfather formerly owned a farm some distance above Berea, near this same stream, on which he had burned limestone gathered from his fields. In this case glacial action had evidently deposited a local supply of limestone boulders, which had slowly broken down and become a part of the overflow soil farther down the valley.

Stratified limestone supply in non-glaciated areas carried by stream action. In the valley of the Walhonding river, in Coshocton county, is another example of stream action affecting the lime supply. In this instance stratified limestone which formerly lay in the tops of the highest hills has been disintegrated and turned into soil. A rich valley with an abundance of lime upon which luxuriant alfalfa grows, is the result. Only an occasional hill top yet retains the original outcrop of limestone which is now being applied to many of the hill fields for best results in growing the common field crops of the section. Near Warsaw, in this valley, is an example of an overflow field growing alfalfa for fifteen years, the field containing an abundance of gravel from the previously mentioned limestone. The owner of a near-by farm was recently offered fifty dollars for the limestone on one such hill to be used upon the neighboring fields which are deficient in lime. Alfalfa has been grown for at least fifteen years in the Walhonding valley with marked success. One overflow field produced good alfalfa crops for eleven years, after which it was plowed in order to break the bluegrass sod that had formed and was immediately reseeded with success. The average yield per acre of hay for this entire period was about four tons per season.

Hydrochloric acid treatment. Various soils in this valley and elsewhere were treated with a dilute solution of hydrochloric acid and found to contain enough lime to cause an immediate effervescence. Upon most soils this acid solution produces no different appearance from that which as much water would cause, but where enough lime is present the action is similar to water boiling in the soil. A small bottle of this acid, diluted with four parts of water to one of acid, was carried for this use during the study. When desired a small portion of this liquid was poured upon samples of the soil as removed from the earth at various depths, or it was often poured upon the surface of the soil. Many successful alfalfa fields visited were not rich enough in lime within a depth of three feet to show any efferescence when treated with this hydrochloric acid, although every alfalfa field rich enough in lime to respond to this treatment was producing profitable crops. This was found true on alfalfa fields in various sections of the State and with different soil conditions. However, it must not be inferred that the other essentials for successful alfalfa culture were lacking in any case.

Litmus paper test. The litmus paper test is apparently of little value in determining the soil requirements for alfalfa. This test does not determine the amount of lime in the soil but merely indicates on which side of the neutral point a particular soil may be. A very small amount of lime might be applied to certain soils and cause the soil to show a favorable litmus test reaction. Such a condition, which might possibly suit some of the farm crops, would not meet the requirements of alfalfa, which demands several times the amount of lime used by some of the other crops. It is true, however, that in a large number of cases over the State alfalfa is successfully growing on soil not sufficiently supplied with lime to show any reaction when treated with hydrochloric acid. Therefore, it is not to be concluded that the hydrochloric acid test will detect the alfalfa soil, but it appears evident that where soil is found to react, that soil may with some degree of certainty be expected to grow alfalfa profitably, providing it is properly treated otherwise.

Soil auger. Throughout this investigation a soil auger was carried, with which soils were easily sampled to a depth of 30 inches. The auger used was a 1¼ inch wood auger, with the gimlet point removed, and the auger extended as shown in Figure 5.

Glacial limestone in freestone areas not moved by stream action. In Morrow county is an example of a locality in which fine alfalfa is grown upon upland soil containing no stratified limestone according to the State reports. A fine field of alfalfa has been giving three crops each season for the past seven years near the village

of Edison in this county. The gravelly hill portion of this field was treated with hydrochloric acid and showed a marked reaction. The more level portion of the field upon which the alfalfa was not so good showed no effect from the acid. A good stand remained over the entire field after having been seeded eight years, yet the hill portion grew the more luxuriant hay crops. Glacial action has probably been the cause of this local supply of limestone gravel. It is barely possible, however, that a bed of marl which was noted in that county may have had something to do with the lime in the soil of the lower ground.

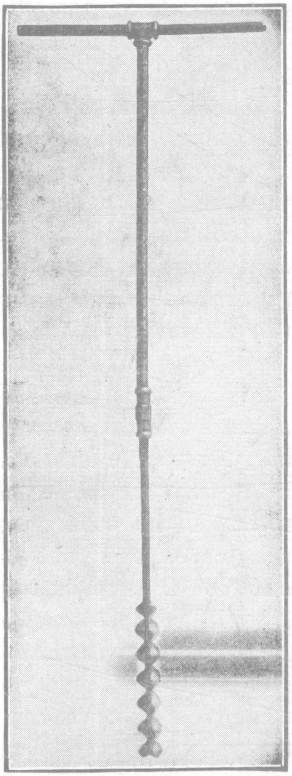


Fig. 5. Sectional soil auger used in sampling soils of alfalfa fields.

Old lake bed field growing four crops of alfalfa. In southern Williams county there is a field which yielded four crops of alfalfa this past season (see Fig. 6). Numerous shells are found as deep as three feet in the soil of this vicinity, which were doubtless deposited there by lake action. The available supply of lime associated with the other essentials in this field produces ideal conditions for profitable alfalfa growing. Frequent gravel banks are found in this lake bed area, some of which cover acres. A few artesian wells were located, indicating a uniform water table during the entire year. The quick drainage through a gravelly limestone soil in this case is very similar to parts of both Preble and Champaign counties having artesian wells and also especially adapted for alfalfa.

Old lake bed sand growing profitable alfalfa. It may be well to mention another phenomenal success which is situated in the same lake bed, but in Fulton county near the Michigan state line. The soil in this case, which in places is yellow sand to great depth, is probably entirely different from anything that will be found elsewhere in the State. The soil of this field is pure sand to a depth of at least 20 feet. This sand is so light that a winter cover crop is required to keep it from blowing into ridges. Alfalfa is profitably grown upon this and other fields of like nature in this vicinity. Previous to the growing of alfalfa upon this farm the owner had desired to sell and, being unable to find a

buyer, offered it at public auction but failed to secure the first bid. Seven years ago an old orchard on this farm was seeded to alfalfa which is yet standing. It was cut for hay until other grass came in with it to such an extent that it is now being pastured with hogs. Although this soil does not produce a sod easily, a satisfactory one is forming of itself in the seven-year-old alfalfa.

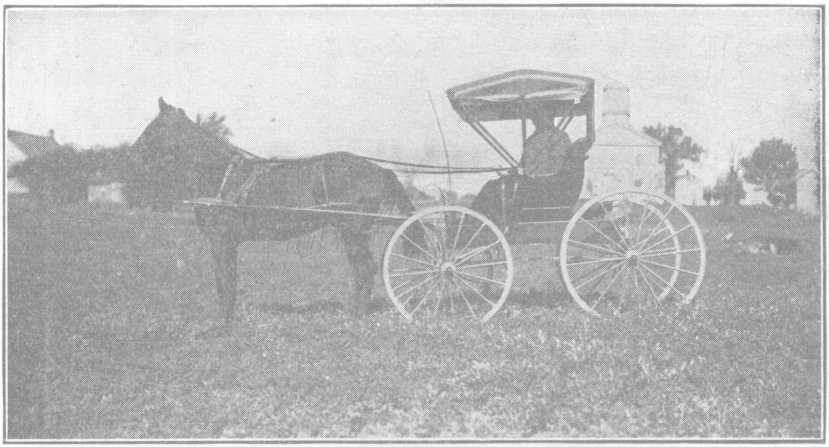


Fig. 6. Fourth crop of alfalfa already harvested, October 26th, in the northwest corner of Ohio. This soil contains numerous limestone deposits to a depth of three feet, due to the old Maumee Lake once covering this part of the state.

Sands vary in lime supply. So far as observations were made the lake bed sand is apparently richer in lime and better adapted to alfalfa growing than sand found along the streams of the State. Observations in Cuyahoga, Allen and Shelby counties lead to the conclusion that alfalfa is not profitable in the sands of some of the streams passing through them. The lake bed condition was evidently more favorable for the preservation of the lime than the stream systems which tend to wash any soluble material farther down the water course.

Lime supply often more abundant in sub-soil. Several instances have been observed where alfalfa was better in dead or finishing furrows than in the remainder of the field, indicating among other things more abundant lime supply in the sub-soil than near the surface. Also it is noticed that the sub-soil remaining on the surface after filling a tile drain often marks a much larger growth of alfalfa, while other fields which were equally in need of drainage do not show this difference. It is quite evident that one soil may be more deficient in lime near the surface while another

may be as well supplied at the surface as in the subsoil. It is frequently found, however, that the sub-soil at a depth of two or three feet contains enough lime to react from the hydrochloric acid treatment while the surface soil may not so respond. In one particular case in Ross county in a field seeded to alfalfa, no action was to be seen when the acid was applied to the soil from as great a depth as could be reached with the soil auger, whereas there was a noticable effect when dirt excavated from the depth of six feet was given the same treatment. Several acres of this soil have been growing alfalfa successfully from the original seeding, which was made fifteen years ago. Four crops per year are usually harvested from this field and sold on the market (see Fig. 7).

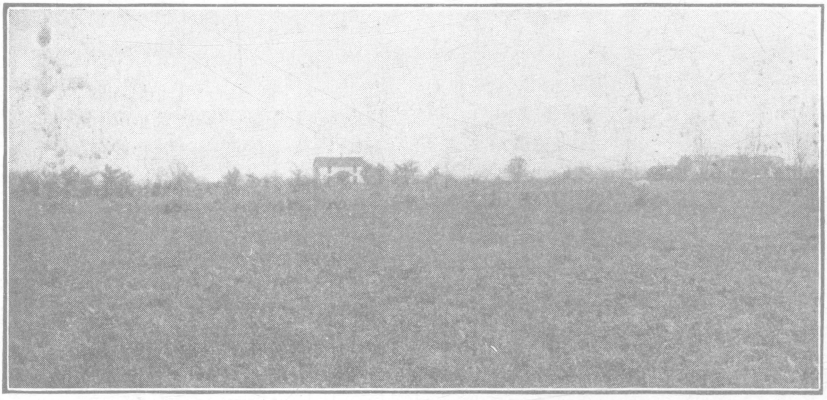


Fig. 7. Fourth crop of alfalfa from an 8-acre field at Chillicothe belonging to a cemetery seeded 15 years ago, with no later expense except harvesting and selling the hay crop, which the past season found a ready market at $15 per ton direct from the field.

Application of lime upon field with sub-soil rich in limestone. The effect of an application of lime upon a new seeding of alfalfa in Seneca county was marked during the first season but could not be observed the second one. This was not due to the apparent reason of the applied lime having been exhausted the first season, as will be evidenced by the fact that both limed and unlimed portions were improved the second season. The owner was no doubt correct in concluding that the surface soil in which the alfalfa roots grew the first season was deficient in lime and that for this reason the application of lime was beneficial the first season; but as the roots grew deeper the second season they reached down to where there was abundance of lime so that the applied lime was of no value to the deeper-rooted plants. The same condition exists in parts of Hamilton county where alfalfa fields from which the lime has been

exhausted from the surface soil are underlaid with an abundance of limestone in the subsoil. In this soil the alfalfa starts poorly the first season while the roots are small and near the surface, but a marked improvement takes place the second season when the roots have reached the rich, limestone soil. A number of local instances of peculiar lime supply and its effect upon alfalfa have been observed. One such example is on a limestone soil in Allen county fairly well adapted to alfalfa, which showed the more luxuriant growth of alfalfa where the Trenton limestone from an old oilwell had been deposited upon the surface soil (see Fig. 8).

Fig. 8. Trenton limestone deposited from an old oilwell on limestone soil in Allen county, showing a much more luxuriant growth of alfalfa on the right than on the remainder of the field.

Sources of lime supply. From the foregoing it will be evident that success with alfalfa, so far as lime is concerned, depends, in the limestone areas of Ohio, upon one or all of three natural conditions: (1) nearness of original limestone to the surface; (2) glacial action; (3) stream action. In the freestone areas it depends upon (1) glacial action, (2) stream action. The old Maumee Lake bed, as shown in Figure 4, is another source of lime supply contributing quite largely to the success of alfalfa in a number of counties throughout northern Ohio. Marl is of benefit in a limited area.

Drainage. The problem of drainage in Ohio is as local as that of lime supply; however, in numerous cases there is an association between the two. The gravelly and sandy soils of the State are as a rule well drained, although in some such soils it is necessary to tile-drain in order to lower the water table sufficiently for the alfalfa to stand. The stony soils are usually perfectly drained, and in case

they were not, artificial drainage would not be practical. In many cases the stone, gravel and sand are limestone or of limestone origin. The remaining soils of the State vary from quickly self-draining soils to those which are so tenacious that water will stand over the tile for a considerable time. Localities in both Mahoning and Putnam counties were visited where the clay is so tenacious that farmers report that it is of little use to tile-drain unless the ditches are filled with a more quickly draining material than the clay itself. Cinders have been found practical for this purpose where available and have been used to advantage in both of the counties named. Still another condition is reported in Clermont county, where in certain localities a very fine, dark-colored sand is carried by the drainage water through the joints of the tile, to such an extent that it has been known to fill the drain so that the water is unable to pass through.

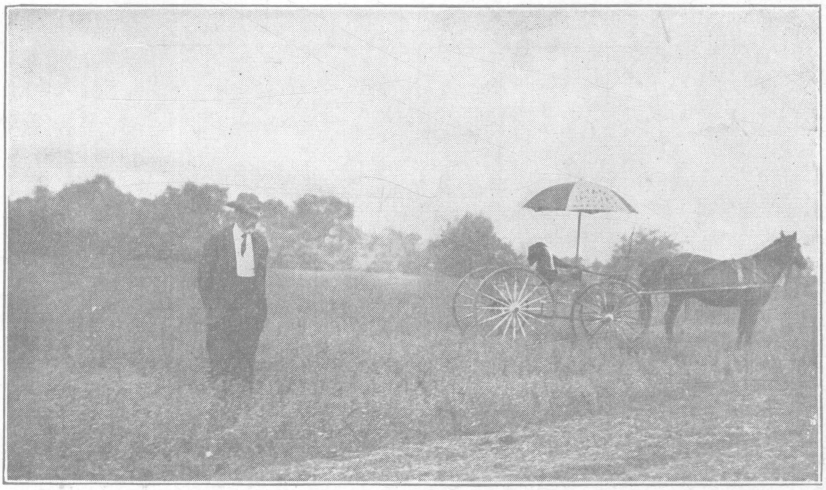


Fig. 9. Photograph of a Shelby county alfalfa field showing the smaller alfalfa growth upon unbroken clay at least 30 inches in depth (under wagon), compared with the same soil having a 2-inch layer of sand at a depth of 18 inches (where man stands).

Differences due to lime and drainage. Probably no better example of soil variation and its effect upon alfalfa growth could be found in Ohio than in a field visited in Shelby county, where four degrees of success are attained with a distinctly different character of soil underlying each. The use of the soil auger showed the best alfalfa in this field to be growing over a limestone gravel pit, bordering which is the poorest alfalfa over a sand pit. The remainder of the field is a stiff clay soil, part of which is solid clay to the depth of the soil auger. On this clay soil the alfalfa grows a little better

than over the sand. Scattered through this clay portion of the field there are spots where the alfalfa is nearly as fine as over the gravel pit. In such places the soil auger revealed a 2-inch layer of sand at a depth of about 18 inches. The difference in growth was so marked that the effect of the two inches of sand is easily detected in Fig. 9 where the taller alfalfa, growing under this condition, is compared side by side with that growing over the clay sub-soil without the layer of sand.

The striking differences in this field are largely due to lime and drainage, with the possibility of deficient plant food in the sand pit. The important point in practice is cause and effect rather than any supposition relative to the theory of the matter, and just to what extent each is a controlling factor in the results upon the four soils described is of less importance than to know that both lime and drainage are essential to success. In this instance it is quite probable that both glacial and stream action contributed to the soil differences. Drainage is none the less essential because lime is in abundance. This point is well illustrated in Ross county in a field responding readily to the acid treatment, but which required from forty to sixty rods of tile drain per acre in order to keep the plants alive during the freezing and thawing of early winter and spring.

This particular soil is a very tenacious clay, through which it was difficult to penetrate with the soil auger while sampling the soil. The field was satisfactorily ditched for the regular farm crops previous to the growing of alfalfa, but additional draining was required for the growing of this crop (see Fig. 10).

In this instance it was found that the only way to locate accurately the needed drains was to examine the alfalfa and run the ditches through the injured portion of the field in the winter or early spring during the period of greatest moisture. The resulting benefit to the alfalfa crop was considered many times that of the injury done to it in placing the tile through the growing crop. Four fine crops have been harvested the past season, yet more tiles have been placed in readiness with the expectation that another spring will reveal other spots that may be improved by passing a tile drain through them. Few upland soils in Ohio containing an abundance of lime present a more adverse situation under which to secure a stand of alfalfa than the foregoing example in Ross county.

While this is true of stiff clay soils, it is just as evident that other soils lack this retentive quality to such an extent that sufficient moisture is lacking during the dry summer season. Such a field is situated upon the Chagrin River in Lake county. Portions

of this field support a luxuriant growth of alfalfa while spots with the same surface soil make a much smaller growth, this being the more noticeable as the season advances. On examining these spots to a depth of three feet it was observed that while there was sufficient moisture in the sub-soil under the best alfalfa to cause the auger to retain the soil when it was withdrawn from the ground, under the poor spots the soil fell loosely from the auger, apparently containing no moisture whatever. Otherwise the appearance of the sub-soil in each instance was very similar, thus showing that the lack of growth was doubtless due to the sub-soil water escaping unduly.

Fig. 10 Tile drain located after the alfalfa was seeded, and placed where the crop was injured the following spring during wet weather. Notice the narrow strip of alfalfa injured by placing the tile drain.

Surface drainage. On the more tenacious soils it is the opinion of alfalfa growers that surface drainage is of considerable value in more quickly removing the water, though the field may be reasonably well under-drained. Under certain conditions water may cover an alfalfa field for several days without harm, while on the other hand a short period of inundation often results in injury to the crop. Overflow river bottoms are often inundated and a sediment of as much as two or three inches deposited on the alfalfa without injury providing it occurs during winter or early spring. After such an overflow it has frequently been necessary to disc the soil thoroughly to break the crust before the spring growth of alfalfa could start. It has frequently happened that a sudden freeze before the water has been removed from the surface results in a thin sheet of ice forming over the alfalfa and working considerable injury. This may readily occur over tile-drained fields from which the water drains slowly.

Water table. The prevailing opinion among both writers and growers that alfalfa requires a low water table is not found to be correct in all instances. It would appear that a much more important consideration is that the water table be comparatively stationary; that in case of a high water table the water remain at that high level during the whole season. The plant must have water and air and the peculiar tendency of alfalfa is to grow deep to find the moisture needed. If after reaching this depth the water table is suddenly raised for a considerable time the air will be cut off from the roots below that level so that they cannot thrive. It will be manifest, however, that if the water remains within a few feet of the surface during the dry season the roots will never reach the greater depth and greater supply of plant food that they will in other soils. A striking example of this is located in Logan county on a farm situated along a small creek. Artesian wells are constantly flowing in several places upon this farm, and previous to tile draining the water always stood on the surface of the valley fields. Tile drains have been placed at a depth of about thirty inches in order to lower the water table. Crawfish continue to work in this soil the same as before tiling. At any time during the year a pebble dropped into one of these holes may be heard striking water on a level with the tile drain.

An example of a rotation with water table three feet below surface. Alfalfa is very easily seeded in this soil and is being used in rotation with potatoes quite successfully. The system is extremely flexible, as the alfalfa will stand any number of years desired, after which it is plowed down and the field planted to potatoes. The crops following alfalfa outyield those in any other cropping systems tried upon this particular farm. The weed problem, which is so troublesome in rich bottom fields, is greatly reduced by the alfalfa, which starts early in the spring and is harvested three or four times each season. The potatoes following such a crop are much more easily cultivated. When it is desired to seed alfalfa again the potatoes are planted early and dug in time to sow the alfalfa the same season.

Natural drainage. Quite a large percent of the alfalfa grown in Ohio is in soil having natural drainage through gravel or rock. This is particularly true in large areas of the older centers of production like Hamilton county, containing an abundance of stratified yet disintegrating limestone, and Logan and Champaign counties, which have large areas of gravelly soil giving perfect drainage.

Injury to tile drains. Reliable information regarding the injury of alfalfa roots to tile drains is not easily secured. Only one instance has been positively reported in which the roots actually

filled a tile drain. This instance was in Sandusky county, where a field of alfalfa had stood for seven years over a three-inch tile drain placed at a depth of about three feet. Thirty rods of this drain were taken up and the tiles were found full of a continuous mass of fibrous roots. This farmer is of the opinion that a period of four years' growth would not form sufficient root system to injure the drains. In this field the tiles were only carrying water during the rainy periods of the year. This fact would no doubt be an important factor and under conditions of moisture that varied from this field in this respect the same trouble might not be experienced. The possibility of injury to tile drains should not be taken too seriously when numerous fields are growing alfalfa over tile drains with no apparent trouble. This instance was related to a farmer of Defiance county who suggested his own experience as possible evidence of there being a mistake as to the cause of the tile filling with roots. This farmer also took up a tile drain which was under an alfalfa sod and found it filled with plant roots which he attributed to the alfalfa until afterwards he found the same condition in an adjoining field in which there was no alfalfa. Anyone in doubt about injury from this cause can easily examine the tile drains before they are seriously injured and if necessary plow up the alfalfa. If true at all it is probably only with the most favorable surroundings for alfalfa that the stand will remain long enough for the roots to cause such injury. Under such favorable conditions the profits from four or five tons of hay annually from each acre will justify an occasional reseeding, or even the relaying of a few ditches should it become necessary.

Effect of streams. Not only are the valley soils of the larger streams of the State in many cases liberally supplied with lime but also their drainage is usually rapid and complete. The map showing the centers of alfalfa production in the state indicates a much larger acreage along the streams (see Fig. 2). However, when alfalfa becomes better understood its area will doubtless be extended into sections which are not now considered to be suited to the crop. An observing alfalfa grower of Logan county remarked, "Years ago when we began growing alfalfa upon our farm we thought our best corn land would also be best for alfalfa, but in later years we have learned that our best success with alfalfa is on hillsides where corn is not so profitably grown." This soil is a gravelly clay with more limestone gravel upon the hills than on the lower and more level fields. He suggests that the hills have more tendency to dry out when the corn crop is most in need of moisture, while the alfalfa which roots deeply in this better drained limestone gravel soil may reach moisture at greater depth.

Southern hills favorable. The length of the season is considerably affected by the lay of the ground. On southern slopes it is longer than elsewhere. An alfalfa field facing the south at a steep angle was visited in Hamilton county. This field was in blossom before the middle of May and was ready for harvest a few days later. Numerous hills of a similar nature in that county are growing good alfalfa. However, at present the best is grown along the valleys of the larger streams.

CLIMATIC CONDITIONS AFFECTING ALFALFA

Latitude. A difference of more than 200 miles in latitude between Northern and Southern Ohio must result in considerable variation in alfalfa methods. While soil variations are probably by far the more important, the latitude can by no means be overlooked by those contemplating this crop. The question of a nurse crop may in part depend upon climate, as likewise method and time of seeding, all of which are considered elsewhere. The winters in northern Ohio are considerably colder than in the southern part of the State, and constant cold weather with a small amount of alternate freezing and thawing is expected. In the southern part, on the contrary, the soil more frequently thaws during the day and freezes again at night. It is not uncommon for snow to cover the ground during most of the winter in northern Ohio, while farther south the ground is more frequently bare. These are probably among the differences causing more uncertainty, during certain seasons at least in securing a stand of alfalfa farther south. It is therefore evident that even more attention may be required to promptness in removing the surplus water in the southern part of the State where the soil is doubtless subjected to a greater amount of alternate freezing and thawing than in the northern part. No information has been obtained that would lead to the conclusion that continued cold weather is injurious to alfalfa under the ordinary methods of handling the crop.

First hay crop often woody in southern Ohio. It is a common complaint among dairymen in Hamilton county that the first crop of alfalfa is of a coarse, woody nature, and that it is difficult to make a good quality of hay from it, but owing to the fact that few if any are certain of the source of the seed, it is difficult to know how much the variety might have to do with this condition. However, it is longer in maturing than the later crops, thus allowing more time for the stems to become tough and woody. In order to guard against this they find it necessary to cut this crop while less mature than is the practice with later cuttings. On this account as well as that of less favorable weather conditions than later, it is often

impossible to make a good quality of hay from the first crop unless field covers are provided for the hay during the process of curing. In alfalfa centers farther north this difficulty from woody hay is not experienced and there is no discrimination against the first crop by dairymen. The first crop is allowed to reach the same maturity as later crops without any injury to the hay. This brings the harvesting at a later date, which means a possibility of better weather conditions. The season, too, being considerably later farther north, also brings the first cutting at a later date.

Adaptation of Alfalfa to Ohio conditions. The alfalfa fields of Ohio indicate that geological formation and other local factors affecting the soil are more important to the successful growth of alfalfa than to that of the other general farm crops of the state. The shorter season of northern Ohio requires a smaller eared corn to mature, even though the soi may be better than in the south. The oat crop is evidently more profitable in northern Ohio, irrespective of soil conditions ,as shown in the map of centers of oats production.* Alfalfa apparently differs in this respect, so that when other things are equal there is probably as much to be said in favor of alfalfa in either extreme of the state.

Besides the various differences of soil, drainage requirements, and climate, that are found in the different parts of the State, the same unexplainable requisites that are noticeable in alfalfa growing, for example, make two sections of equal soil fertility, in one instance excellent for corn while in another particularly adapted for potatoes. The physical condition of a soil may be improved in many cases by intelligent methods, yet the availability of plant food and the success with which various crops succeed, is found to be dependent not only upon the more commonly considered soil factors but also upon the varying capacity of different plants to utilize the plant food in the soil as well. This fact is evidently an important factor in locating the various crop centers* of the state. The value of soil analysis, which may express the entire amount of plant food, depends, so far as practice is concerned, upon its correlation with the growth of farm crops.

ALFALFA METHODS LOCALLY APPLIED

Viewpoint. The presentation of the subject to this point has been from the viewpoint of soil, drainage, climate, etc., in its relation to alfalfa as observed in the field investigation. It is now desired to continue the discussion of the same general question from the standpoint of the crop itself, in which it will be endeavored to present methods that in the actual experience of farmers contending with these various environments have best succeeded in different parts of the State.

*Circular 100, Ohio Experiment Station.

NURSE CROPS

One of the more frequent questions asked is regarding the nurse crop, and it is usually implied that the question is one that it is possible to answer once for the entire State, and indeed it is so answered by many growers who refer to their own local experience as proof. Such unwarranted conclusions have unfortunately misled many new growers into seeding a large acreage without actual knowledge of local conditions, besides deterring others from even attempting to grow the crop.

Purpose of nurse crop. Observations over the state would indicate the following regarding the nurse crop: (1) under the most favorable conditions in Ohio nurse crops of various kinds are grown for the additional profit they bring without injuring the alfalfa in any way; (2) under less favorable conditions nurse crops of various kinds are grown with no hope of added income from the crop but with the idea of its being less harmful and more easily controlled than weeds that would otherwise compete with the alfalfa; (3) under the least favorable conditions under which alfalfa is grown nurse crops result in injury and loss of the alfalfa. The larger part of the state must be classed under the last division. A number of counties will safely come in the second division while there are probably only limited localities that can be put in the first class.

When the nurse crop is profitable. Alfalfa fields have been visited in Allen, Athens, Coshocton and Fulton counties which were successfully seeded with oats and in exactly the same manner as red clover is commonly seeded. The yield of oats that was threshed from the field thus seeded in Allen county was sixty bushels per acre.

Oats in Fulton county. Oats harvest was in progress during the first visit to the Fulton county field and the sheaves of oats were green with the tops of the alfalfa plants cut off by the binder set at a moderate height. The oats were very heavy and slightly leaning in places, yet the stand of alfalfa was uniformly good over the entire field. The alfalfa tops in the oat sheaves were probably six inches long on an average. A later visit was made and the field was photographed showing a crop of alfalfa that could have been harvested profitably had the owner not desired to have it pass the winter uncut (see Fig. 11). Any one of the four fields mentioned in this and the preceding paragraph could have been cut for haythe first season had it been thought wise to do so.

Fig. 11. Field of alfalfa seeded among oats in Fulton county exactly as red clover is seeded throughout Ohio. Photographed in October the same season the oats were harvested, when a fair crop of hay was ready for the harvesting.

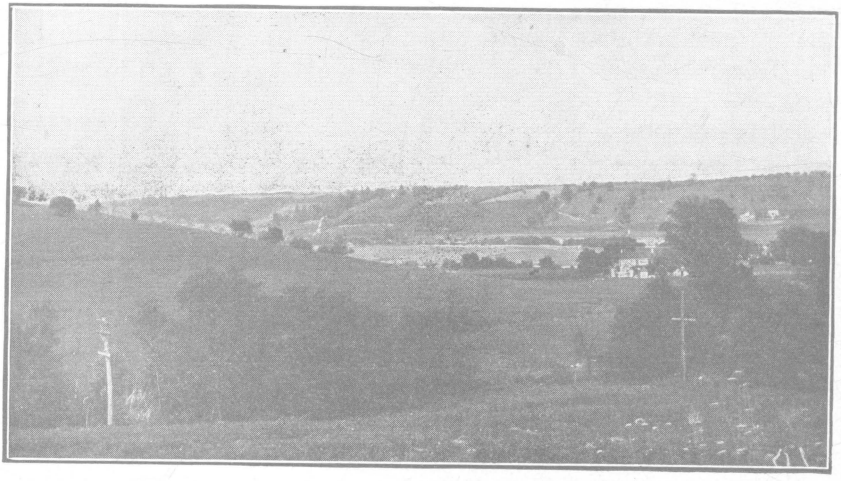


Fig. 12. Typical alfalfa fields easily seeded on the hills of the lower Miami River in Hamilton county. Erosion due to cultivation and neglect has permanently injured many of these limestone hills.

Wheat in Hamilton county. One successful grower on the banks of the Miami river in Hamilton county who seeds alfalfa in the wheat has found that the hill tops of his farm will start alfalfa readily but that before winter it will have perished, while on the hillsides and valley land it succeeds perfectly. His practice has been to seed lightly to wheat in the fall, then harrow the wheat with

a spike-tooth harrow about the first of April, when the alfalfa seed is sown, and possibly harrow again if the weather conditions will permit. The wheat is harvested in the usual way (see Fig. 12). Instances are also at hand in Hocking county in which alfalfa has been successfully seeded in wheat fields.*

Hay crop the first year. Some experienced growers, who find it possible to succeed according to the methods described, prefer to omit the wheat or oats and seed the alfalfa alone, bearing in mind about the same precautions they would consider wise in seeding red clover. Under the ideal soil conditions required for this method the larger amount of hay secured during the first season is often found equal in value to the nurse crop that otherwise could have been grown. However, the very small percent of farmers who have soil conditions so well adapted for alfalfa growing are probably in much less danger of following the wrong method than are those farming under more adverse conditions.

Barley as nurse crop. In the second place, and under less favorable environment, where the nurse crop is grown primarily for keeping down weeds, a number of grain crops have proven valuable in the estimation of Ohio growers. Spring barley probably has the best reputation and is used more or less wherever alfalfa is grown with a nurse crop. One advantage it is claimed to have over oats is the smaller number of blades, thus allowing more sunshine to reach the alfalfa. One trouble that is common in the use of all nurse crops is the sudden exposure of the small alfalfa plants to the direct rays of the sun, when the nurse crop is removed. In order to overcome this difficulty as much as possible it is a common practice to harvest the nurse crop before maturity. This is particularly true of oats, which ripen comparatively late. The nurse crop is usually seeded more lightly than would be done if it were not for the alfalfa.

Pasturing. In a number of localities growers have disposed of the nurse crop by pasturing with hogs. Although the majority of growers object to any form of pasturing, a number of favorable reports have been received regarding this method. One point in favor of this method of disposing of the nurse crop is that there is no sudden exposure of the young alfalfa plants to the rays of the sun during the hot, dry part of the season.

Rye. A number of growers report as successful quite a unique plan with alfalfa in which fall rye is seeded in the spring as a nurse crop. It is found that fall rye seeded in this way will make sufficient growth to keep back spring weeds and by about

*Circular 107, Ohio Experiment Station.

the middle of July the rye will begin to die. The advantage of this plan would appear to be in avoiding the sudden exposure of the young alfalfa plants to the sun as in the previous case of pasturing, and also in overcoming some of the objections to this pasturing method.

When the nurse crop is a robber. The third condition and that under which the nurse crop has proven a disadvantage represents the least favorable conditions under which alfalfa is grown in Ohio. The most frequent reason for alfalfa not growing is reported to be a lack of moisture. The same cause is also attributed to the increasing uncertainty in securing a stand of red clover, especially in southwestern Ohio. The particular localities where alfalfa cannot be grown easily with a nurse crop probably have the same rainfall and in some cases soils equally retentive of moisture, as those in which alfalfa grows most readily. It is therefore quite reasonable to suggest that where alfalfa grows less readily a lack of something in the soil besides water is the controlling factor. In soils more abundantiy supplied with these elements though with no greater amount of soil water the plant is satisfactorily nourished. Coupling with this the fact that each ton of alfalfa hay contains 42 pounds of actual lime and also that many soils are lacking in lime even for the common farm crops which require a comparatively small amount of lime, a shortage of this substance would naturally be a controlling factor.

Alfalfa vs. red clover. Under the conditions last named, where lime must be supplied to the extent found necessary on the Experiment Station farm at Wooster, the experience of farmers in general supports the conclusions announced in Circular 91 of this Station, in which it is shown that at present alfalfa is no more profitable and possibly less so than is red clover when everything is considered.

VARIETIES OF ALFALFA

Acclimated seed. The growing of alfalfa has yet one particular obstacle in the way of its success in Ohio, if we are to take other farms crops as an example. Alfalfa is about the only one of our commonly grown crops from which seed is not profitably produced in Ohio, at least for seeding purposes. Alfalfa is an exception in this particular and will evidently remain so for some time at least, although numerous Ohio farmers are occasionally growing seed for their own use. The advantage of producing a crop from acclimated seed is well illustrated in the corn work of the Experiment Station. It is equally reasonable to expect that an improved strain of alfalfa will in time be produced from home grown seed which will be better suited to the particular soil requirements of Ohio than that now used.

Variety tests on the Station farm. Special tests conducted upon the Experiment Station farm at Wooster, by the Agronomy Department have shown that the source of seed is a factor. When seeds from different sources are sown side by side in cultivated rows, some strains withstand the winter much better than others, this being particularly noticable in seedings of several years' standing. Variations of growth are also noticable; certain strains having their own peculiarities, such as a larger number of stalks from the same root, low bunchy growth, tall and slender plants, heavy foliage, coarse woody stems, etc.

Cooperative variety tests. A number of tests have also been conducted by the Experiment Station in cooperation with farmers in various parts of the State, in which varieties of alfalfa seed, which were supplied by the Bureau of Plant Industry, U. S. Department of Agriculture; were compared in the hope of finding sources of seed from which might be secured something of special value for Ohio growers. So far, the work has shown little if any evidence of marked difference of value. The same point has been studied during the past summer's investigation in the field with no tangible proof upon which conclusions can be based. One serious obstacle in this investigation is a lack of knowledge among seed dealers as well as growers relative to the source of seed purchased. Should a farmer secure a seeding of especially valuable quality in few cases could he have any assurance of securing more seed from the same source.

SEEDING PROBLEMS

Unnecessary trouble in preparation for seeding. In a few localities of the State, to which alfalfa is particularly adapted, unnecessary time and expense have been expended in securing a stand where less expensive methods would have succeeded equally well. Failures in growing alfalfa under soil conditions which are particularly unfavorable have caused many to conclude that alfalfa is a comparatively difficult crop to seed, which is no more true than to say that potatoes are a difficult crop to grow in Ohio because there are some sections of the state in which potatoes are largely bought for home consumption owing to the difficulty of growing them.

The numerous methods of seeding have no doubt often been a stumbling block to the prospective grower, while a classified association of methods with environments would in most cases reduce the reasonable methods of procedure for any one field to a small number.

Reseeding old alfalfa fields. Alfalfa has been seeded after almost all of the other farm crops with no particular failure that can be traced to the effects of the preceding crop. Following alfalfa with the same crop after a seeding of long standing is probably not a wise

plan, as illustrated by the results of two growers who succeeded in growing profitable crops from the first seeding for ten years, when it was decided to break the ground and immediately reseed. In both fields the second seeding failed with no apparent reason. Both farms are especially well adapted to alfalfa, as would be indicated by the first seeding remaining profitable for so long a time. One of the fields mentioned is owned by an orchardist who feeds the alfalfa to sheep in order to provide manure for enriching the orchard. When it is remembered that alfalfa is especially rich in the soil elements of plant food and that three crops were removed each season for nine years at least, with nothing returned to the field, it is not remarkable that a shortage of plant food existed for the young alfalfa plants starting upon the same soil. An exception to this failure was observed in Coshocton county, in the case of an overflow field which was successfully reseeded after standing for the same time as the previously mentioned fields. Aside from the question of plant food, however, most farmers consider the other principles of crop rotation of sufficient value to induce them to follow some kind of rotation.

Fig. 13. July seeding of alfalfa and red clover side by side, on the Tuscarawas river in Tuscarawas county. Photographed in October of the same season showing a larger growth of alfalfa on the right than of red clover on the left.

Previous crop. An increasing number of farmers are growing an early maturing crop, such as peas, potatoes, sweet corn, etc., which can be removed in time to successfully seed to alfalfa the same season. The cultivation of such crops prepares an ideal seed bed in most cases, which is comparatively free from weeds. The one common objection raised against this practice is the possible lack of moisture due to the demand of the previous crop. In cases where

this is considered a menace to the stand of alfalfa it is a frequent practice to give the same cultivation with the early crop omitted. This method has the advantage of killing the weeds and retaining the maximum amount of moisture.

Hardiness of alfalfa. The ease of seeding alfalfa is well illustrated in a number of comparisons with red clover, in some of which alfalfa grew and the red clover failed. Where conditions were favorable it was observed in Preble, Butler and Tuscarawas counties that alfalfa is as readily seeded as red clover. It is further shown that, under favorable alfalfa conditions alfalfa makes a larger growth during the first season than does red clover (see Fig. 13).

The seed of alfalfa is considerably larger than that of red clover and for that reason should start a more hardy plant than red clover. The experience of growers would indicate that the more exacting soil requirement of alfalfa is the only cause of difficulty in seeding it. For a number of years growers have been advising beginners to mix a small amount of alfalfa seed with red clover seedings. This has resulted in alfalfa being scattered through many fields of red clover where it seems able to compete with the clover.

The natural hardiness of any grass cannot be more accurately determined than by placing that particular grass in actual field competition with other grasses for a number of years. Such an experiment was arranged on the Morgan county fair grounds twenty years ago, in which twenty-four grasses and legumes were seeded in small plots. The field has remained in grass ever since, thus giving each plot an equal chance. The alfalfa, unlike several of the others, has not extended its area in the least from the original seeding; but the greater number of the others have been eliminated within the 20 years by the "survival of the fittest", blue grass having largely taken their places as would be expected. The alfalfa, however, continues to grow, although a well established blue grass sod has occupied the same plot for years. It is certainly safe to conclude that any plant that can compete with blue grass under field pasture conditions for twenty years and not be eliminated has some claim for hardiness under Ohio conditions.

Seeding alfalfa in growing corn. Repeated trials have proven that it is possible in a number of sections to seed alfalfa in the corn field after the last cultivation of the corn.* Under slightly less favorable conditions a Logan county farmer has succeeded in the same way with the exception that only one stalk of corn was grown in each hill. This had the advantage of the same cultivation with less

*Circular 107, Ohio Experiment Station.

drain upon the moisture of the soil than if a full crop of corn had been grown. Also the less amount of shade made by the single stalk of corn in each hill improved the conditions for the young alfalfa. The yield of corn from one stalk in each hill would make this method of seeding alfalfa much less expensive than where the use of the ground is lost for an entire season, as is so often considered advisable. The repeated experience of growers who have found alfalfa more hardy than red clover under the same conditions would suggest possible value in the experience of an Athens county farmer who has found that red clover is much more certainly secured upon his farm when seeded upon fairly compact soil than upon freshly plowed soil. He is of the opinion that the same is true in seeding alfalfa. Judging from the success of various farmers who have alfalfa mixed with red clover, there is a possibility of our really having made alfalfa seeding harder than necessary under certain conditions. As in seeding red clover, an important factor in seeding alfalfa is evidently the supply of proper moisture for the delicate young plants before the roots have penetrated deep into the soil.

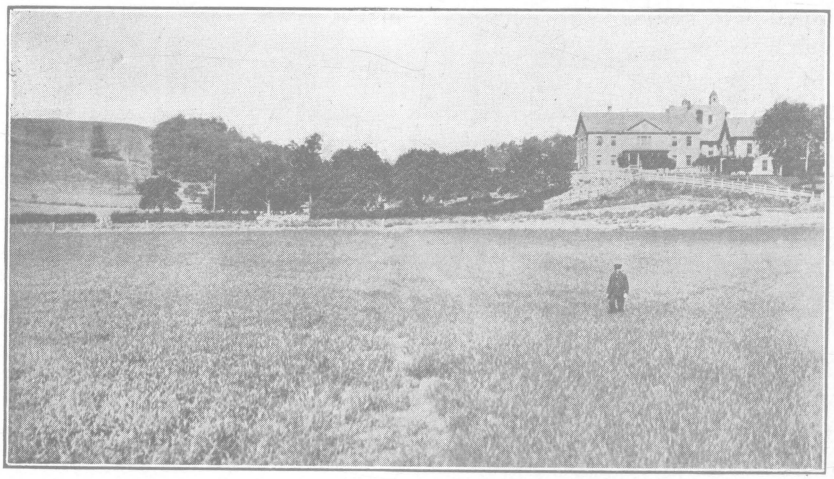


Fig. 14. Early and late seeding on Tuscarawas county infirmary farm in cooperation with the Experiment Station, showing late seeding (on the left) to be more free from weeds than the early seeding.*

Time of seeding. Behind all of the perplexing methods that have been practiced in seeding alfalfa, is seemingly the fundamental advantage of seeding as early as possible in the spring in order to secure a large root system to better withstand the winter and, prob-

*In the experiments of the Agronomy Department of the Ohio Experiment Station, which have been carried over several seasons and which have included various nurse crops and preparatory crops, the only satisfactory stands have come from mid-summer seeding on spring fallowed land with no nurse or preparatory crop. These experiments have been conducted under soil conditions belonging to the third class of those mentioned on page 23.—C. E. THORNE.

ably even more, the extremes of weather during early spring following. Just to what extent this is practical would depend upon a particular knowledge of how late it will be necessary to delay seeding in order to safely eliminate the injury from spring weeds.

Combination seeding. Not many farmers have seeded alfalfa with timothy as is so much practiced with red clover. A few such seedings have been located throughout the State which have proven very satisfactory. In such a combination either the timothy is cut quite immature, when the first crop of alfalfa should regularly be cut, or no harvesting is done until the timothy is in the usual condition for hay. In the latter case the following crops that season will be mostly pure alfalfa, while in the former case there will be some timothy in both the first and second crops. One grower in Washington county has been following this method successfully for eight years. In a field seeded four years ago, which had been allowed to stand unharvested until the timothy was ready to harvest, the alfalfa was well filled with seed. The alfalfa was not a uniform stand in all parts of this field and in places where it was thickest the timothy had made so much larger growth that it had lodged. A number of similar examples were located, both in and out of the limestone areas of the State, where alfalfa has in the same manner improved the grass with which it was growing. From investigations recently reported by the Cornell Station it would be safe to infer that the quality of the non-leguminous grass would also be improved.*

Blue-grass. In a number of fields the alfalfa plants are surrounded with a blue-grass sod extending over the whole area. Under such conditions the blue-grass has invariably been of a more luxuriant growth than when the legume was not present. The value of this method of securing a stand of blue-grass is not generally appreciated. However, a number of farmers recommend it as an ideal way in which to secure a good blue-grass sod or to improve an old one. This feature has formerly been considered only as an impediment to growing alfalfa. Where permanent pasture is desired it may, however, prove to be very valuable.

Implements used in seeding. The mechanical arrangements for seeding alfalfa are various. Probably a large percent of the alfalfa is seeded with one of the many satisfactory hand seeders. On some soils in which the seed will be sufficiently covered no additional covering will be needed, while under different soil conditions it is found best to follow with a weeder, and in yet heavier and more compact soils a harrow is used after seeding. It is a very common practice when seeding with a hand seeder to sow only one-half of

*Bulletin 294 Cornell Experiment Station.

the seed the first time and immediately cross with the remainder at right angles. In this way a more uniform seeding is secured. The weeder-seeder as shown in Figure 15 has proven valuable for a number of years on a light sandy soil in Lake county for seeding both alfalfa and red clover. This implement is apparently worthy of much more general use in soils adapted to the use of the weeder.

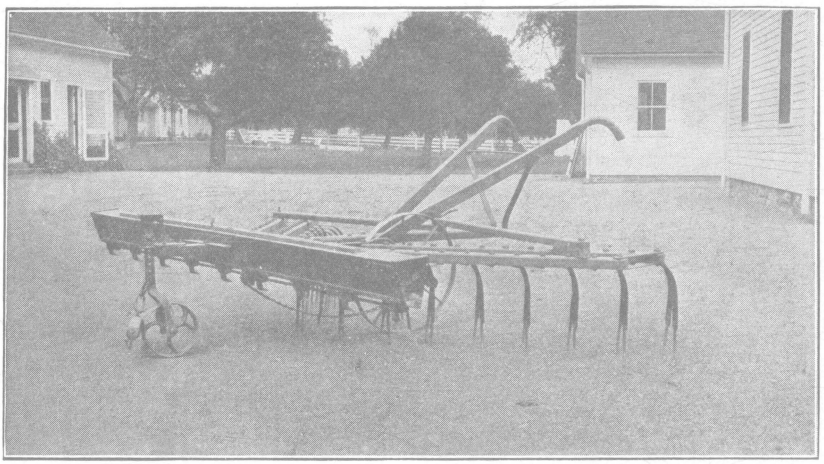


Fig. 15. Weeder-seeder. Combined cultivator and grass-seeder found valuable in seeding both alfalfa and red clover in some of the light soils of northern Ohio.

Many fields of alfalfa seeded to a spring nurse crop are drilled in with a common hoe drill, having a seeding attachment for grass which permits seeding at the same time the nurse crop is drilled. By shifting the dividing board it is possible to drop the alfalfa seed either in front or behind the drill hoes, the decision regarding which will depend upon soil conditions to be determined by trial. The disc drill can be used in the same way but it has not proven as satisfactory on some soils as the hoe drill. The ridge between the drill rows is a valuable protection in case of dry weather soon after seeding. It is also true, however, that a dashing rain may remove more of the seed with the ridge, than without it.

Amount of seed per acre. Although the amount of seed sown per acre varies to extremes over the State, there appears to be no convincing evidence that any section should vary in this particular from the amount proven best on the Station farm at Wooster, which is about 15 pounds per acre.* It is not uncommon for a poorly prepared field to show poor germination that may be attributed to a light seeding, when in fact a lack of moisture is really the cause. On certain soils that drain slowly and are subject to injury from alternate freezing and thawing, some growers seed more heavily for a protection against such injury.

*Circular 91, Ohio Experiment Station.

In general, then, 15 lbs. per acre is an abundance of seed unless the conditions are unfavorable. The price at which alfalfa seed sells would indicate the wisdom of avoiding these unfavorable conditions.

Reseeding. Where partial stands of alfalfa that appear too valuable to destroy have been secured, various methods of reinforcing the stand have been tried. Only one success has been reported within this investigation, and even in this instance while the stand secured was good in some places, in other places it was almost a failure. When seed is sown among old plants the trouble is that ordinarily the old plants both, by their shade and root systems, so weaken the young plants near them that they fail to grow. All the attempts at thickening up the stand which were observed have been in soils that were not the most favorable for alfalfa. From this it would not be safe to conclude that alfalfa cannot be thickened under more favorable conditions. However, this is seldom required upon ideal alfalfa soil.

Inoculation. Alfalfa is now grown so generally and has been so for so many years that inoculation is present to such an extent that its effect can only be studied in the newer sections where it has not been grown before, and very probably in many such places sweet clover, which has been proven to give the same inoculation as alfalfa, may be found growing. It is probably due to such conditions that in so many cases results have been contradictory in this respect. A few instances are at hand, however, showing that under certain conditions artificial inoculation has brought about a distinct improvement in the crop produced, whereas in most fields no attention has been or need be paid to it.

The effect of inoculation was apparent within three weeks upon a new seeding of alfalfa in Logan county. This was easily detected by the darker green color of the field treated with soil from an old alfalfa field. Many farmers who had trouble in securing a stand in former years are at present succeeding with the same methods. They attribute their success to the presence of inoculation which was formerly lacking.

Nodules. So far as examinations were made the alfalfa which continued to grow well showed inoculation as indicated by the nodules on the roots of the plants, while in a number of unsuccessful fields no nodules were found (see Fig. 16). An interesting example was located in Licking county where individual plants in the same field were of two distinct colors. The dark green plants were found to have nodules on the roots while the yellow and less thrifty plants were not so supplied. Another instance, in soil lacking in lime, was

observed in Washington county, where nodules of exceptional size were found in a portion of the field where a brush pile had been burned. The fibrous roots to which the nodules were attached had entwined the particles of charcoal, forming clusters of nodules.

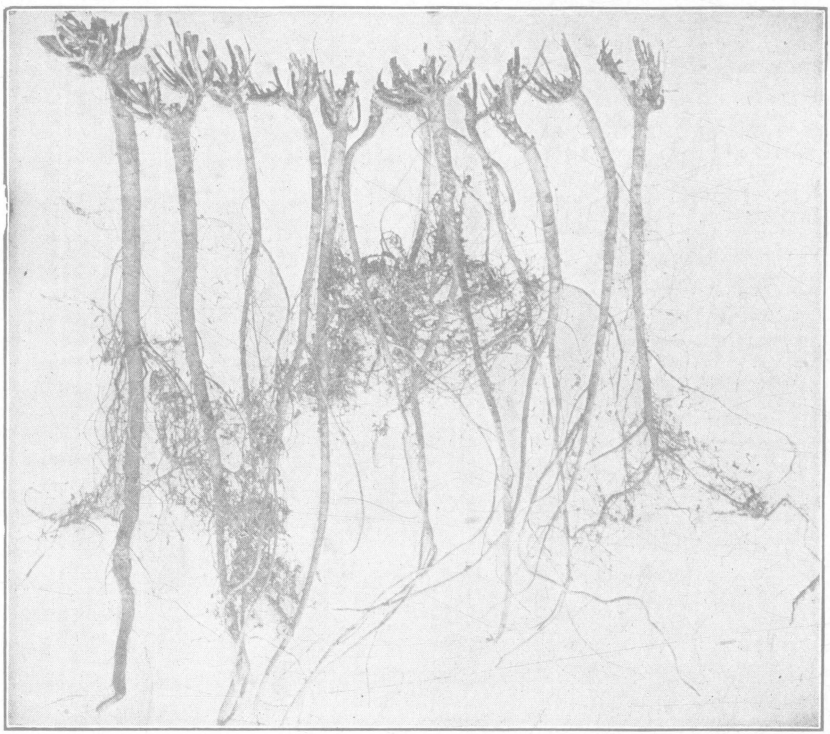


Fig. 16. Nodules on the fibrous roots of alfalfa which are necessary for a profitable crop to continue. Photo supplied by Dept. of Agronomy.

In Shelby county nodules were located upon the tap root of a plant that was removed from the soil (see Fig. 17). This was not observed elsewhere in the fields examined.

THE USE OF MANURE AND FERTILIZERS

Top-dressing. The application of manure previous to seeding is a common practice and may cause alfalfa without inoculation to grow fairly well for a short period, but the effect is not permanent. The benefits of manure as a top-dressing are commonly apparent. Another common practice is to apply the manure lightly during the winter in order to have it well settled before the first crop is harvested the following spring. In one instance in Logan county, where the manure was applied by hand at the rate of twenty-five loads per acre, the results were injurious. This was repeated for

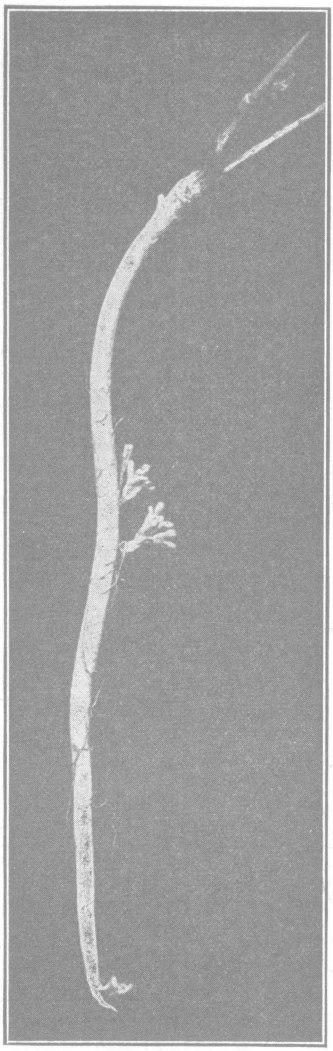


Fig. 17. Nodules on a tap root of alfalfa plant. They are commonly found upon the fibrous roots. Their presence is considered a safe guide to soil inoculation.

three years with the same results. The reason given by this farmer was that alfalfa is naturally a dry climate plant receiving its moisture from deep in the soil, while by the application of a heavy covering of manure additional moisture is retained near the surface during the spring when the soil contains the greatest amount of moisture. In the same county is another instance of injury due to nearly the same cause. In this case manure was hauled from the chicken house during the early spring and scattered over the alfalfa by hand. The alfalfa was so much injured that the growth ceased and the plants turned yellow as far as the application extended. The effect of feeding hogs is very marked upon a portion of a limestone hillside in Preble county. The hogs were fed during the early fall of 1909 and the following spring the field was plowed and seeded to alfalfa in June. A perfect stand of alfalfa now grows upon all of the field excepting the spot where the hogs were fed new corn and there it is a complete failure. In contradiction to this observation is another field in Montgomery county upon which hogs were also fed previous to seeding alfalfa upon a clay hill and upon which the best alfalfa is now growing upon the spot thus manured. Much further evidence will be necessary to justify final conclusions regarding the effect of heavy applications of manure upon alfalfa under the various conditions that are to be found over the State.

Commercial fertilizer. Very little commercial fertilizer has been used throughout the State in starting alfalfa and the experience of those who have used it would indicate that where other conditions are correct it is seldom needed. The effect of a brush pile having been burned upon soil afterward seeded to alfalfa has proven a

marked benefit in a number of instances. A conspicuous improvement in alfalfa growth has been observed in Union county where brick were formerly burned. Judging from this last fact the inference may be drawn that the benefit of burning the brush may have been from the effects of the burning as well as from the effects of the ash. This is further confirmed by the test of one grower who applied wood ashes without results.

CULTIVATING ALFALFA

Various harrows used. The practice of cultivating alfalfa to eradicate grass and weeds is rapidly increasing in favor with farmers in general, although trials have proven it to be impractical to cultivate it during the first season. Numerous styles of harrows have been used in experiments made in this connection. The work along this line year after year with various implements at the Experiment Station has called attention to the possibilities of such a practice. Manufacturers of harrows are now awake to the coming demand for a style of harrow better adapted to the work than anything yet manufactured. It is an opinion among at least quite a number of growers who have attempted to cultivate alfalfa that the coming harrow must be some style of spring or spike-tooth. Injurious results from using the various forms of disc harrows are experienced in cases where cultivation is delayed for a few days after cutting the crop of hay. This seems to be due to the discs injuring the young, tender shoots after they have attained some size. However, a grower in Fulton county, having a quick-draining soil, finds it practical to disk in the early spring before the alfalfa has commenced to grow. One grower reports an increased crop where he disked after harvest on Saturday, while an adjoining strip given the same treatment the following Monday was injured. The same objection is not raised against the spring-tooth harrow, which does not injure the young sprouts above the surface of the soil like a cutting disc. In one field visited in Ross county the spring-tooth was used without injury eleven days after harvest and when a new growth was six inches high. The vibration of the spring teeth is also considered an advantage over the disc or spike-tooth, in that it more completely removes the dirt and weeds from the grass roots, while if rain follows soon after, the disc often merely resets the weeds instead of removing them. Another grower reports following the deep cultivation with either a light, spike-tooth harrow or a weeder, and sometimes both, to shake the dirt more completely from the weeds and grass roots. The latter treatment is more effective if delayed until the loose dirt has become as dry as possible, when it is more completely removed from the roots of the plants.

Time to cultivate. When cultivation is primarily to kill weeds probably the most satisfactory time has proven to be after the second crop has been removed. This is due to the fact that the days are longer and warmer with the maximum amount of sunshine, all of which are helpful in eradicating grass and weeds. There is commonly less moisture in the soil at this time than when the first crop is harvested, which is also helpful in the same way. The weeds and grass have made most of their growth before the third crop is harvested and for that reason little benefit would result to that season's crop of hay if cultivation was delayed until after this time.

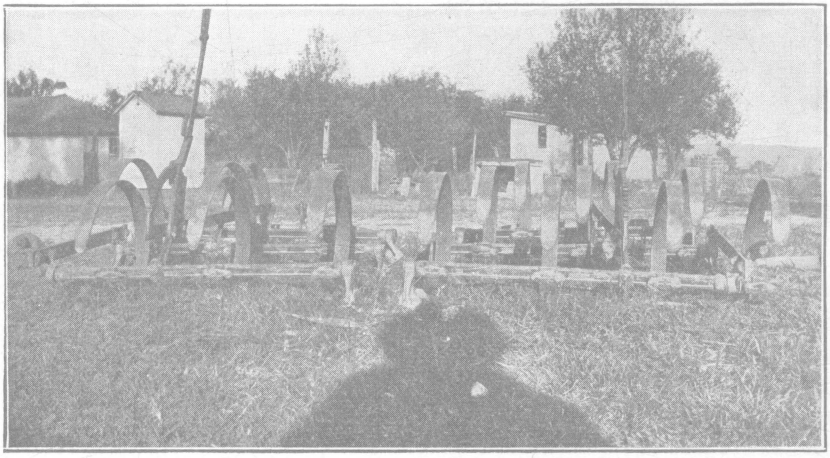


Fig. 18. Springtooth harrow with specially constructed points, more narrow than will be found upon the market. This harrow successfully eradicated blue-grass sod and plantain from an old alfalfa field in Ross county. Eleven cultivations were given to part of the field during one season, without injury to the alfalfa.

Special harrow. One grower made a special harrow for alfalfa cultivation by having a blacksmith repoint the teeth of an old spring-tooth harrow as per Fig. 18. This harrow was repeatedly run over the alfalfa in different directions until little but the alfalfa remained. Occasional spots received as many as eleven cultivations within the season. Shortly before the fourth crop was ready to harvest a second visit was made to the same field. Bunches of dead grass and plantain leaves were scattered over the field, and practically all the plants other than alfalfa were destroyed. The increased yield of hay has been such that the owner plans to continue the cultivation another year in order to conserve the moisture, although it will not be necessary for the same purpose for which it was begun last year.

While the purpose of the cultivation last year was to eradicate the grass and weeds, the effect from the conservation of moisture by the continuous cultivation was doubtless of much value.

Blue-grass sod broken and seeded to alfalfa. The field shown in Figure 19 is in a good blue-grass section of Ross county and has been in alfalfa a number of years with the grass and weeds well established.

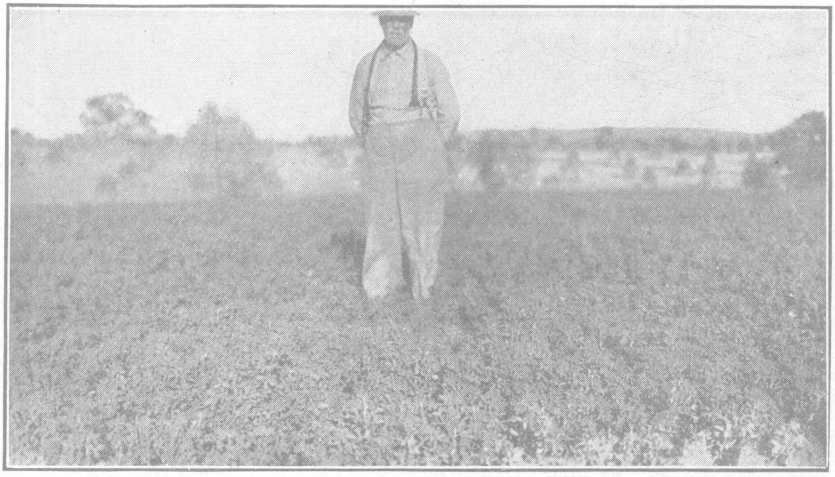


Fig. 19. Alfalfa field in Ross county, which was cultivated 9 times during one season, as it appeared shortly before harvesting a bounteous fourth crop.

This field was cleared of all grass with one season's cultivation to the entire satisfaction of the owner. On the other hand, the idea of some growers is that it will be much more practical and easy to commence cultivation before the grass and weeds have become permanently rooted than to remove them after they are once well set in the alfalfa. One experienced grower in Hamilton county who cultivates alfalfa prefers a blue-grass sod, broken up and seeded to alfalfa, to any other crop. There are few weeds to bother and when the blue-grass returns the second year the cultivation easily removes it before it is well rooted. The alfalfa makes a more satisfactory growth upon such sod than elsewhere upon this farm.

Injury to roots from cultivation. A few diseased roots may be destroyed by cultivation, but it is difficult to find a single healthy root that has been so injured. The hardiness of alfalfa roots is shown by the frequency with which they are found in fields planted to corn after an alfalfa sod. The illustration in Figure 20 is of such an alfalfa root, taken from between the rows of corn after cultivation in the heavy clay soil of southern Ashtabula county, where the prevailing opinion is that alfalfa cannot be made to grow. Repeated

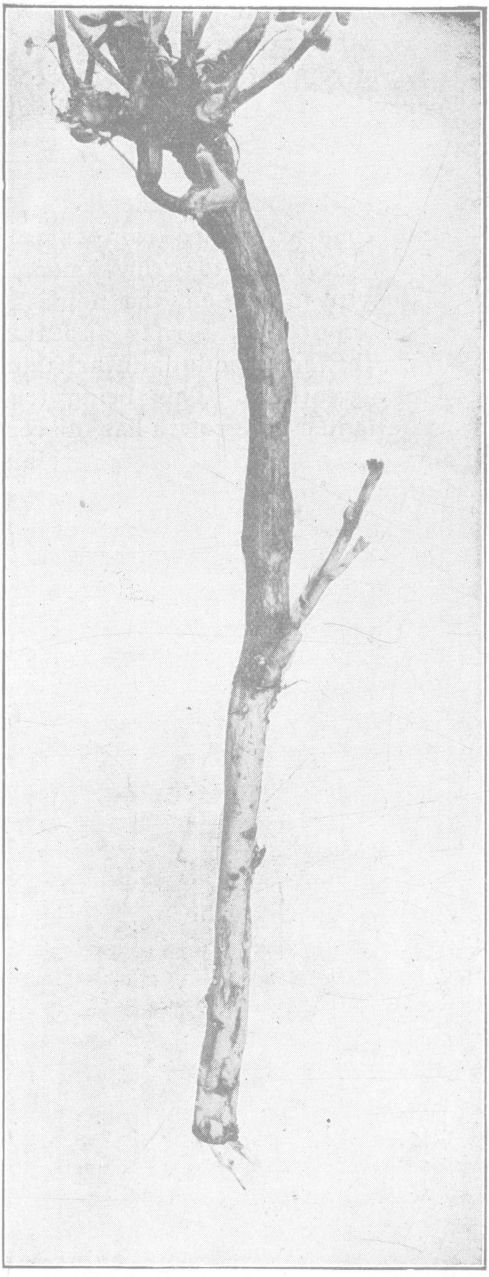


Fig. 20. Alfalfa root taken from between two corn rows in an alfalfa sod field in Ashtabula county. Repeated cultivation of the corn has injured the plant causing it to start a new shoot below the crown.

cultivation had injured the plant growth to such an extent that a new growth was started considerably below the crown of the plant, as may be noticed in the photograph.

INJURY DUE TO VARIOUS CAUSES

Yellow condition a result. Besides the injurious effects of heavy mulching, already mentioned, which may have been due to moisture conditions, the yellow condition of the alfalfa was directly traced in one instance to the effect of manure. This was on a Logan county farm where, previous to seeding alfalfa, strips of both silage manure from the cow stable and ordinary horse stable manure were applied. The alfalfa quickly turned yellow where the manure from the silage-fed cows was used and shortly afterward the same was true of the horse manure strip. Adjoining strips with no manure did not show the yellow condition until shortly before winter, while still another strip on which lime was applied failed at any time to show any signs of turning yellow. Quite frequently such trouble is experienced the first year, when the plant is feeding near the surface, but is overcome later on when the roots reach a greater depth.

Wise to clip whenever growth is stunted. When alfalfa has been checked by drouth, or any other cause, so that growth has ceased, it does not appear possible to renew the growth by creating favorable conditions at a later period. The new shoots will utilize the renewed energy instead of its returning to the old plant growth. An instance of this was observed in Lake county, where the extreme dry weather had completely checked the growth of the second crop when about one foot high. Some time afterward rain came and moistened the soil, causing the new shoots to grow among the former growth. At the time of the visit to the field the new shoots were as high as the old plants and of a dark, thrifty appearance, while the plants of the former growth were of a dull, unthrifty color and no larger than during the dry weather. This being true it would appear to be wise to clip alfalfa in case growth has discontinued for any reason, as it will not increase in value and is possibly an injury to the following crop growing amongst it.

Premature cutting injurious. This fact is in no way contradictory to the experience of numerous growers over the State who find that the premature harvesting of normal crops of alfalfa, if carried to the extreme, will result in a yellow condition of the following crop. The observation of a few growers is that harvesting before the new shoots for the following crop are sufficiently strong to withstand the sunshine, which is suddenly allowed to come upon them when the former crop is removed, will result in the following crop turning yellow. A grower of 18 years' experience with alfalfa in Lake county reports loss in 12 different years by the crop turning yellow and that by accident he found that the trouble could be avoided by more mature harvesting. For this reason he now harvests but two crops each season. He values the two crops having a vigorous growth more highly than the three formerly harvested, when some of them were more or less yellow. Fields are frequently found in which a part of the field, harvested possibly a few days earlier than the remainder, shows the next crop of a yellow unthrifty appearance, while the later cutting is followed by a fine healthy growth.

Injury from long stems remaining uncut. Another condition that has been reported frequently as injurious to the following crop is when under exceptionally favorable conditions in parts of the field the alfalfa has been heavy enough to lodge, so that in harvesting, the long stems remain uncut by the mower, thus leaving a long stubble upon the field. In such cases the following crop does not grow as well as under normal conditions.

Injury from not harvesting late crop of hay. The same idea is further illustrated in the experience of an extensive grower in Montgomery county, who after harvesting the fourth crop from a part of one field allowed it to remain uncut upon the remainder of the field during the winter. The part from which the hay was harvested was not injured by the winter or spring, while the part unharvested was seriously damaged. His observation led him to believe that the roots with no tops were practically dormant during the winter and spring while plants in the same field with large green tops on them remaining alive for a considerable time were more affected by changes of weather, the living tops acting as a conductor of changes in temperature to the root system. In fields where drainage is not perfect this injury may be more than overcome by the value of the tops as a protection from freezing and thawing. Many farmers are harvesting the fourth crop and if it is found necessary a much cheaper protection can be had in the form of a light application of straw or other mulch.

Advantage of short stubble. In this connection a few farmers have concluded that it is best for the succeeding crop to cut the stubble as short as possible and yet not clip the new shoots that may have already started. When it is borne in mind that an old stubble must die back to the crown of the root after each crop is cut and the sap be suddenly transferred to the new shoot, this idea is as reasonable as when applied to the same principle in forestry and horticulture.

Methods of pasturing. Notwithstanding the fact that in the opinion of most growers, it is not practical to pasture alfalfait is not uncommon to find fields that have been successfully pastured with the various farm animals. In most instances the regular clippings are made, although the hay may be left upon the ground. The injury to the roots from trampling is evidently less from pasturing in fields seeded in combination with other grass, thus forming a sod, which acts as a protection to the alfalfa roots.

Clipping or pasturing while wet. Both pasturing and clipping alfalfa while wet with dew or rain has in a number of cases proved injurious to the following crop, which appeared to lack proper vitality, and finally ceased to grow and took on a yellow color.

Insect enemies. Grasshoppers have in a number of instances over the state injured both old and new seedings of alfalfa, although in this respect there appears no reason for more trouble than with red clover. In Montgomery county one alfalfa field was ruined by small green bugs which the owner reported as first appearing a few years ago and continuing each spring until about the time of

harvesting the second crop. During the past season it was difficult for the driver to see while mowing the second crop owing to the cloud of these small insects which were disturbed by the team and mower. Later in the season when the field was visited it was not possible to find a specimen of the damaging insect.

THE VALUE OF ALFALFA AS A WEED EXTERMINATOR

Wild morning glories killed. The value of alfalfa as a weed exterminator has been accidentally discovered in a number of instances. It has been found to be the means of eradicating a number of our worst weeds in several localities over the state. We have the statements of growers in four different counties who have eliminated wild morning glories from their fields by two or three years' harvesting alfalfa. This weed is one of the most persistent and frequently renders rich valley soil almost worthless for many of the farm crops. On some of the fields reported this pest has been so bad that all other means of exterminating it have failed and very little could be produced upon the ground. The frequent clippings received while in alfalfa, and the quick shade which followed each cutting of hay, have killed out the weeds. One grower stated: "Freeing this rich valley soil from the wild morning glories, which for years we have been unable to control, is worth all the trouble and expense of growing the alfalfa, even had it been of no value other than to free the field from the weed pest".

Other weeds. Another persistent weed—Canada thistle—is also reported, by one grower in Lake county, to have been destroyed in an alfalfa field after a few years' harvesting. This, however, is the report of but one experience. The value of alfalfa as a destroyer of a certain class of weeds is no doubt exceeded by no other farm crop, yet this important factor in favor of it has had but little attention on the part of farmers, and is probably not fully appreciated by those who could often use the crop to good advantage with this in mind. While weeds of a certain kind, such as plantain, are but little injured by alfalfa, it is quite evident that a number of our worst weeds will readily give place to alfalfa within a few years. It is also quite possible that with a number of weeds the regular clipping for the same period of time would have the same result, even though the alfalfa were not present.

NUMBER OF CROPS HARVESTED

Length of season varies. The number of crops of alfalfa harvested annually varies with the season as well as the location. During occasional seasons in southern Ohio, where the soil is exceptionally favorable, five crops are harvested when in the

blossoming stage. An extensive grower on the Little Miami River, who has kept an account of hay harvested for the past ten years, shows an average of five tons per acre per year for the entire period. Five crops are frequently harvested on this farm during a single season, and even in northern Ohio four crops are not at all exceptional throughout a few favorable sections (see Fig. 21). Three crops of hay are commonly harvested each season under the more unfavorable surroundings in the state where alfalfa growing is found practical. As already mentioned, a few growers who have alfalfa in combination with other grasses, or to avoid the following crop turning yellow, have found it wise to cut less often.

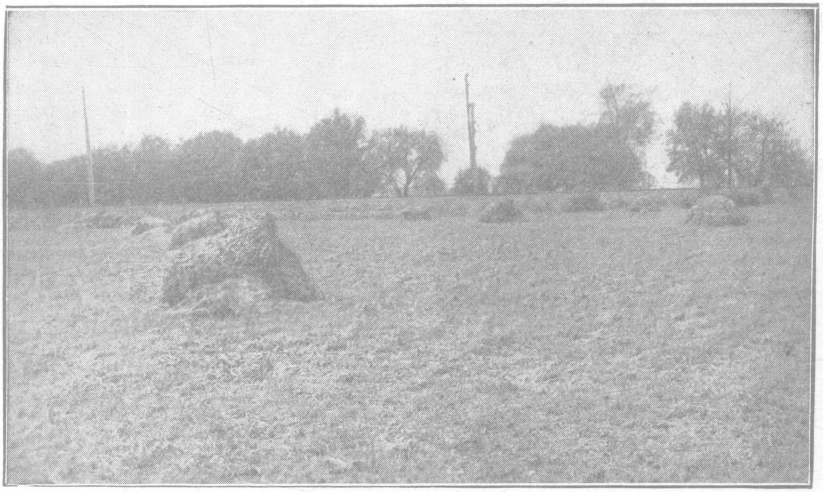


Fig. 21. Fourth crop of alfalfa hay harvested on upland in northern Van Wert county, estimated at one ton per acre. This field is near the southern border of the old lake bed area shown in Fig. 4.

THE PRODUCTION OF ALFALFA SEED IN OHIO

Seed production is at the expense of two hay crops. Where attempts have been made to grow a seed crop it is commonly at the expense of two hay crops, unless the season is long enough to mature the last crop for seed. Of course in either case considerable feeding value is contained in the haulm after seed has been hulled. However, the experience of those who have attempted to grow the seed in this state is that it has seldom been profitable, although comparatively few growers have given the matter any attention. Work of the Agronomy department at the Experiment Station has shown that alfalfa will seed much more readily when mixed with some other grass, as timothy or blue-grass, than when growing alone. Investigations over the state verify this fact in a number of instances. In

Ottawa county an extensive grower left the later crops on two fields for seed, one of which was seeded alone and the other with timothy. A field of two and one-fourth acres seeded alone was allowed to mature seed after the second hay crop of the season had been removed. There were two wagon loads of this seed crop which made but one and one-half bushel of seed. The other field of six acres, which was seeded with timothy, was allowed to mature seed after the first crop of mixed hay was removed. The second crop in this case was pure alfalfa, making only one load for the huller from the field, which yielded six bushels of seed. A few exceptions have been noted in which fair seed crops have been produced from alfalfa seeded alone (see Fig. 22).

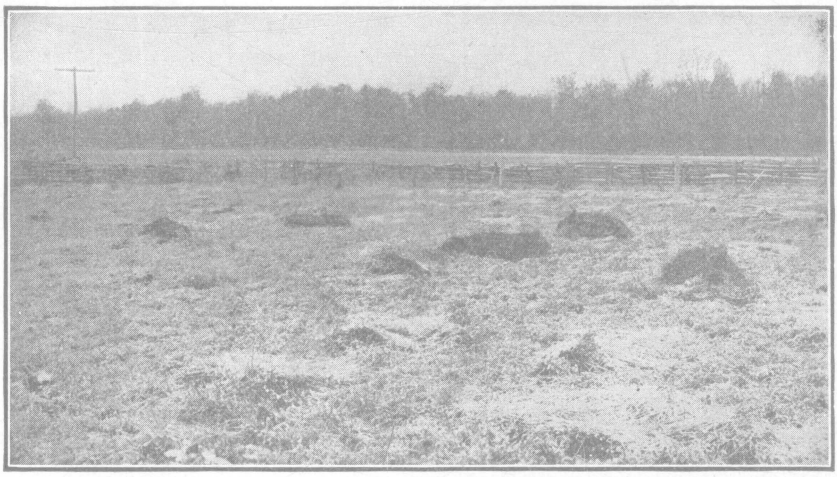


Fig. 22. Alfalfa field in Van Wert county heavily filled with seed during wet weather, harvested the middle of October.

Various crops saved for seed. It does not appear that any particular crop is always best to save for seed but rather, as in the growing of red clover seed, that the weather is an important factor. In a Hamilton county field the fourth crop was allowed to mature seed. This crop was tramped with horses which removed the seed from the stems but not from the hulls. Two flour barrels were filled with seed in this shape from 2½ acres. This seed was mixed with oats the following spring and successfully seeded by a single drilling and a satisfactory stand secured.

METHODS OF HANDLING ALFALFA HAY

Canvas covers. Harvesting methods have not been found to vary in general from those found best in growing red clover for hay. The first crop, coming earlier than red clover, has less favorable

weather, and on this account a number of growers have canvas covers with which to protect the cocks of hay from rain while curing in the field (see Fig. 23). Most farmers look upon bunching the alfalfa in the field for partial curing as requiring extra labor, besides adding to the risk from weather.

Fig. 23. Alfalfa hay in Ross county curing under cloth covers which are five years old, costing 12 cts. each for 40-inch square covers.

Alfalfa hay thin on the ground. There is one advantage in harvesting alfalfa often that may in part offset the less favorable weather conditions and that is, owing to its being thin upon the groun , it dries more quickly. The shorter period of growth produces stems that are smaller than those of red clover, which is also an advantage in curing.

Alfalfa stands more rain than red clover. The experience of growers is that alfalfa hay will stand more rain than red clover without injury. Hay that has remained on the field during rainy weather and is later removed solely to prevent injury to the following crop has been greedily eaten in so many instances by stock grazing upon good pasture, that those who have had such an experience no longer throw away weathered alfalfa hay.

The advantage of mowing in the afternoon. One Champaign county grower has concluded that the loss of moisture that takes place in the heavy alfalfa in the forenoon is more rapid in uncut hay than in that cut in the early morning while it is full of the moisture accumulated during the night. For this reason he does not start the mower until about noon. When this plan is followed the rake is often started to advantage the following morning, as soon as the dew is off. Especially is this true in the case of crops harvested late in the season when the conditions are more favorable for curing.

Tools used in making alfalfa hay. Good hay is being made both with and without the use of the hay tedder. However, its use does not appear to be as essential with a light hay crop, harvested three or more times a year, as with red clover making a much heavier crop at one cutting. A side-delivery clover seed buncher has been successfully used in harvesting alfalfa hay later than the first crop, when the curing process is more rapid. This method places each mower swath in a windrow which can be moved either with a rake or tedder as desired.

Curing hay. If the crop is thin on the ground during hot sunshine it is possible for the leaves to become crisp and even drop off before the curing is completed sufficiently for storing in the barn. It is commonly considered that the curing process is more rapid while the leaves remain green and can help conduct the moisture from the stems. There is little danger of the leaves becoming lost at the time of harvesting the first crop with the shorter periods of sunshine at this season. It seems wise to get the later crops in the cock to cure before the leaves are lost. The superior keeping quality of alfalfa hay as compared with red clover is further shown by the ease with which it is kept in stacks, although the economy of stacking such a valuable product is to be questioned.

Methods of storing hay. An intensive dairyman in Ross county has successfully run alfalfa through a cutting box as it came from the field, and with a blower attached to the cutter the labor was little more than in the regular way of storing hay. In this particular case power was readily available at any time with small cost connected with the dairy. The hay kept perfectly in this way but the plan was discontinued owing to the greater amount of heat generated in the curing, which it was feared might result in more danger of burning the buildings.

FEEDING ALFALFA

Soiling. Numerous town lots in various parts of the state have been seeded to alfalfa and are being soiled to supply a horse or cow during the growing season (see Fig. 24); chickens are also profitably fed in the same way.

Pasturing with poultry. Town lots are commonly very rich, naturally well drained, and will usually withstand worse treatment than the average field. One poultry grower has divided his poultry yard into two parts and successfully pastures alfalfa by alternating chickens between the two. Another covers his alfalfa seeding with wire netting suspended at such a height that the poultry standing on top and picking down through it can not reach the young shoots

until they are well started. Fowls are quickly attracted to an alfalfa seeding near farm buildings and prefer it largely to other grasses. The constant nipping of the points by fowls is frequently reported to be injurious to alfalfa. However, in one farm experience the part of the field over which chickens scratched most produced a crop of darker green color, which was attributed to the cultivation caused by the scratching of the soil.

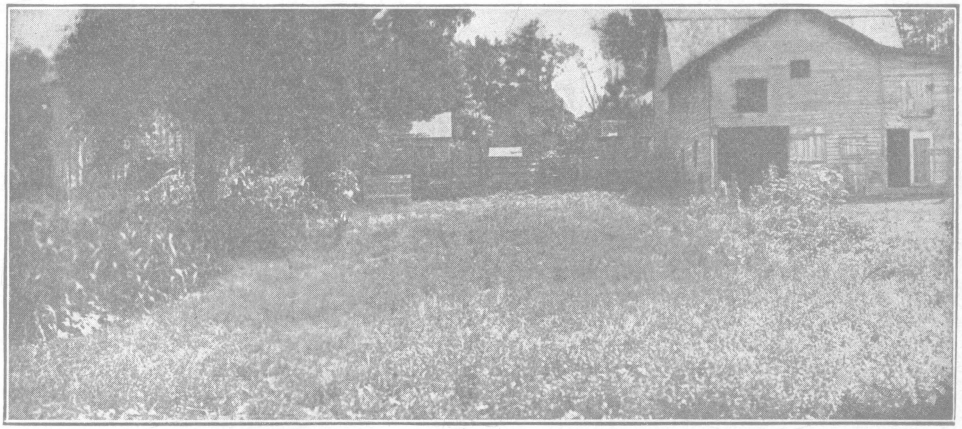


Fig. 24. Townlot in Fulton County seeded to alfalfa for several years which is successfully soiled during the entire growing season.

Silage. Alfalfa has been found well adapted for the silo in connection with corn. It frequently occurs that the third crop of alfalfa is ready for harvest at the time that corn is ready for the silo. A dairyman in Champaign county reports that his best feed is silage composed of one-third alfalfa and two-thirds corn. The advantage over red clover for silage is its more solid stems in place of the larger and more hollow stems of red clover. The larger amount of air contained in red clover silage due to this difference is thought to be the cause of its occasionally keeping poorly in the silo. It is seldom necessary, however, to make silage of alfalfa, as the hay is palatable and when properly cured and fed in moderation all of it is eaten by farm animals.

Poultry and hog feed. The hay is frequently cut in small lengths and fed to both hogs and poultry. It may be fed either dry or scalded and mixed with a concentrate. Several hog raisers have eliminated all feed but corn for brood sows during the winter excepting a small amount of alfalfa fed in this form. On a general stock farm another method found to be practical is for the hay to be thoroughly tossed about as it is thrown from the mow in order to remove as many of the leaves as possible before

it is fed to the horses or cattle. This provides a large amount of leaves that make ideal feed for the hogs and poultry during the winter.

Alfalfa meal. The small amount of waste in feeding alfalfa hay would not indicate a great advantage from alfalfa meal. Only a few mills for grinding alfalfa have been located within the State and none are in regular use. Mills are on the market at a reasonable price that will grind grain and that are also guaranteed to grind alfalfa hay into meal providing it is first run through a cutting box. Sufficient observation of this use of such mills has not been made to justify a statement as to what their practical value may prove to be to the growers of Ohio. Alfalfa meal is quite often fed by stockmen who buy the western meal which has been shipped in. No reason is evident for the alfalfa meal producing any larger returns than the same amount of hay. The price of course is considerably higher and its purchase can only be justified in sections where alfalfa cannot be grown, or by those who are moving about with stock, as in the case of showing at fairs, when it is found necessary to have the feed in the most convenient form possible. It remains to be seen to just what extent alfalfa meal will compete with the other protein feeds commonly sold in sacks. Alfalfa meal is now on sale in many stores throughout Ohio and is sold largely to owners of poultry in villages and towns. This feed is palatable and when moistened comes more nearly supplying a summer feed than anything comparing with it in cheapness. One retail dealer in Montgomery county, who was interviewed, has his alfalfa meal shipped direct from the West, where it is ground, and retails it at 2 cents per pound. It is important to purchase meal that has a bright, fresh color and is free from mold, as an inferior grade of hay can be disposed of most easily in the form of meal.

Palatability. Alfalfa possesses a value, aside from the analysis, which is rather indefinitely expressed in the term "palatability".

COMPARATIVE ANALYSIS OF ALFALFA AND SWEET CLOVER

	Protein	Fat	Nitrogen (free extract)	Crude fiber	Ash
*Alfalfa.....	16.48	2.02	42.62	31.38	7 49
†Sweet clover	20.93	3.09	42 46	25 21	8.87

*Bailey's Cyclopedia, p. 518.
†Bailey's Cyclopedia, p. 468.

Although sweet clover contains as much plant food as alfalfa, a taste of each will quickly convince anyone that while alfalfa is pleasant to the taste sweet clover is particularly bitter. However, in various sections of the State where alfalfa has not been grown and the less exacting sweet clover grows as a weed, certain farmers have found that by harvesting it while the stem is yet soft and green, stock can after a time be taught to overcome their dislike for it and profitable results be thus obtained.

Bloat. In pasturing alfalfa with classes of livestock subject to bloat, at least the same precaution is necessary as in pasturing red clover. Besides the advantages of blue grass already mentioned, it probably has a distinct value, in combination with alfalfa to be pastured, as a precaution against bloat. Timothy would no doubt have the same value in this particular. Many farmers have lost stock from pasturing alfalfa, when wet with dew or rain, and in some instances death has resulted after it was dried off and while the sun was shining brightly in warm, dry weather. However, no case of injury has been reported from pasturing alfalfa where it was growing with other grasses or where livestock had access to such grasses.

A few farmers have reported injurious results other than bloating from feeding alfalfa hay, but no exact evidence of any particular injury has been received. In most cases it would appear that the trouble has been due to excessive feeding. Few farmers realize that alfalfa is so much stronger than other hay that a much smaller amount is sufficient.

Alfalfa fed to driving horse. A doctor who has an extensive country practice in Hamilton county keeps but one driving horse, which is fed each day but a few ears of corn and a limited amount of alfalfa hay. His experience of years in feeding no hay excepting alfalfa to driving horses has led him to the conclusion that the limited amount of hay fed is the secret of his success. A few liverymen have been interviewed who are feeding alfalfa hay in connection with timothy to good advantage.

Economy of feeding alfalfa on the farm. Excepting in the older sections there is usually little demand for alfalfa hay and it sells extremely cheap as compared with other kinds of hay. In a few sections where it has been grown for a number of years it has a good market. But when the large amount of plant food in the hay is considered it would seem wise to arrange to feed it upon the farm in order to return the manure to the soil. However, the experience of growers who have followed alfalfa with other crops would indicate that the need of this manure on alfalfa ground may not be detected

for a number of years, as might also be true with red clover. This fact may be due to the deep-rooted alfalfa drawing the fertility from a greater depth than other plants and depositing it in the upper root system which on decaying provides considerable plant food readily available for the following crop. A long continuation of this practice evidently would deplete the soil to a greater depth than would otherwise be possible.

PROFIT FROM ALFALFA

Alfalfa compared with corn. Another point to be associated with the amount of plant food removed from the soil is the income from the crop. Few farmers have any accurate records upon which net profits are safely computed. However, comparisons will give a fair basis upon which general conclusions may be based. One grower in Clermont county, upon relatively cheap land, reports the following comparison between the sales of a corn and an alfalfa crop in 1908. The alfalfa in this particular field was 5 years old.

38.33 bu. of corn per acre @70 cts.	$26.83
3.55 tons of alfalfa hay per acre @$12.00	42.60
Gross profits in favor of alfalfa on one acre	$15.77

The labor cost for this season was $1 per acre for the alfalfa field while the cost of the labor for the corn crop was not kept, owing to the more complicated nature of the various operations involved, although it is evident to any experienced farmer that it is several times the cost of the hay crop. The above figures were based upon a 15-acre corn field and 4½-acre field of alfalfa. Figures compiled by Mr. W. L. Elser of this Department show that of 142 fields of corn aggregating 1939.24 acres, grown in various parts of Ohio, the labor cost of growing an average acre was $10.98. In the same way it was figured the cost of harvesting 31 fields of alfalfa aggregating 140.41 acres was $3.74 per acre. From a considerably smaller number of fields, regarding which it was possible to secure accurate figures, it was shown that the average cost of seeding an acre of alfalfa was $5.46.

Rental profits. Another field of 19 acres in Athens county, seeded in 1908 upon overflow land, was rented on the shares and the owner's half in 1909 was sold for $250 in the field. In 1910 the first three crops were contracted for $300 as they grew, with the option of the fourth crop upon payment of an additional $100. The season was so favorable that a fourth crop was harvested, thus producing $400 for the season, or in other words, a little over $21 per acre from the 19-acre field for the owner's share (see Fig. 25 and Fig. 26).

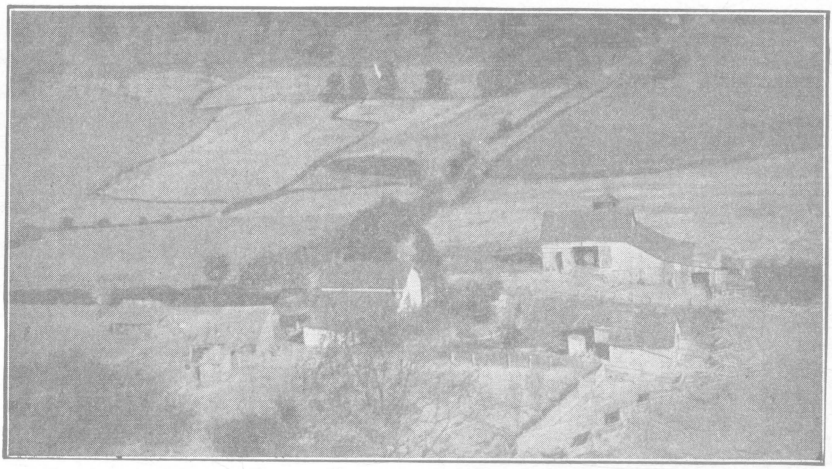


Fig. 25. Farm scene in a rich limestone area of Athens county, Ohio, where alfalfa 11 years old is producing 4 crops annually upon hillsides from 300 to 400 feet above the valley. The owner reports reasonable profits upon a $250 per acre investment from land that is similar to an adjoining farm priced at $40 per acre.

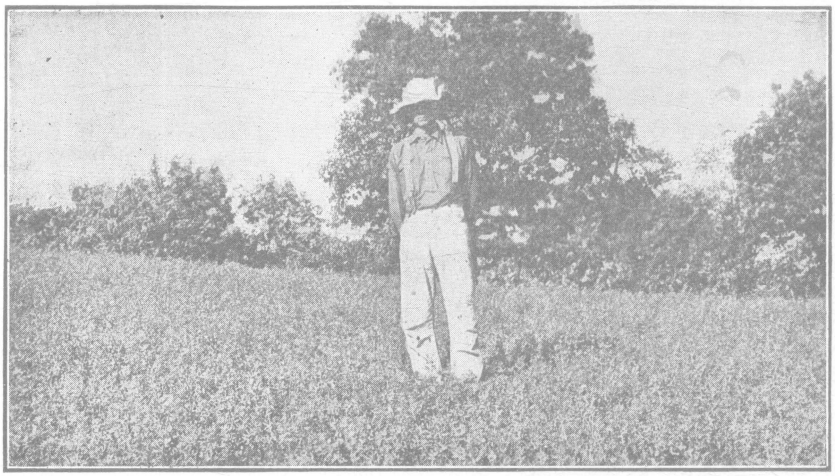


Fig. 26. Fourth crop of alfalfa on field seeded 11 years ago. Loose layers of limestone are near the surface causing perfect drainage. The preceding photograph was taken from this field.

Profits of feeding alfalfa to cattle. A Montgomery county grower near Dayton reports a yield of 6 tons per acre from a 16-acre field in 1909, for which he was offered $18 per ton. Instead of selling it he went to Chicago and bought cattle to which it was fed at an additional profit besides returning a large amount of fertility to the soil.

The examples given are probably the extremes, in two of the three cases at least, and cannot be repeated excepting in a few places over the State, although an encouraging standard is raised for those who understand the possibilities and adaptability of their soil.

No farmer will find all the various points gleaned from this investigation of the past summer throughout the State true for his particular case. However, from the experiences of so many alfalfa growers, each reader contemplating alfalfa growing can no doubt profit by some of the mistakes as well as by some of the successes that others have made. The Experiment Station will be glad to be kept in touch with the experience of all growers of this important crop.

SUMMARY

Numerous farmers have been found, in many parts of Ohio, to whom alfalfa is not a new crop.

So far as climatic conditions are concerned, no evidence has been found that northern Ohio is less adapted to alfalfa than the southern part of the State.

An abundant lime supply and thorough drainage are indispensable to the successful culture of alfalfa.

Many successful fields of alfalfa have been found on well-drained bottom lands, such lands usually being comparatively well supplied with lime, but when equal drainage and lime supply have been found remote from the streams, alfalfa is grown successfully.

The ideal drainage conditions for alfalfa appear to be those in which the water level is maintained at a uniform depth throughout the season.

The so-called "nurse crop" is profitably employed with alfalfa only under the most favorable conditions. In less favorable conditions the nurse crop is a protection against weeds that would otherwise be more injurious to the alfalfa than the nurse crop itself, while in the larger part of the State the nurse crop is usually a disadvantage and frequently ruinous to the alfalfa.

Under the most favorable soil conditions alfalfa has been seeded with wheat or oats as successfully as red clover.

Numerous fields of alfalfa have been found which have produced profitable crops for ten years after seeding, but it has not been found practicable to grow alfalfa again upon such fields until after a long period in other crops.

Alfalfa has been found useful in choking out such weeds as wild morning glory.

Alfalfa has in some instances been successfully seeded in combination with other grasses.

Timothy and blue-grass are noticeably improved when growing in combination with alfalfa and when grown in such combinations alfalfa has sometimes been successfully pastured.

Clipping alfalfa when immature or while wet from dew or rain, has frequently resulted in injury to the following crop.

Inoculation has been found advantageous in localities where neither alfalfa nor sweet clover has previously grown, but the necessity for artificial inoculation is becoming less each year, owing to the more general growth of alfalfa over the State.

CONTENTS

CONTENTS